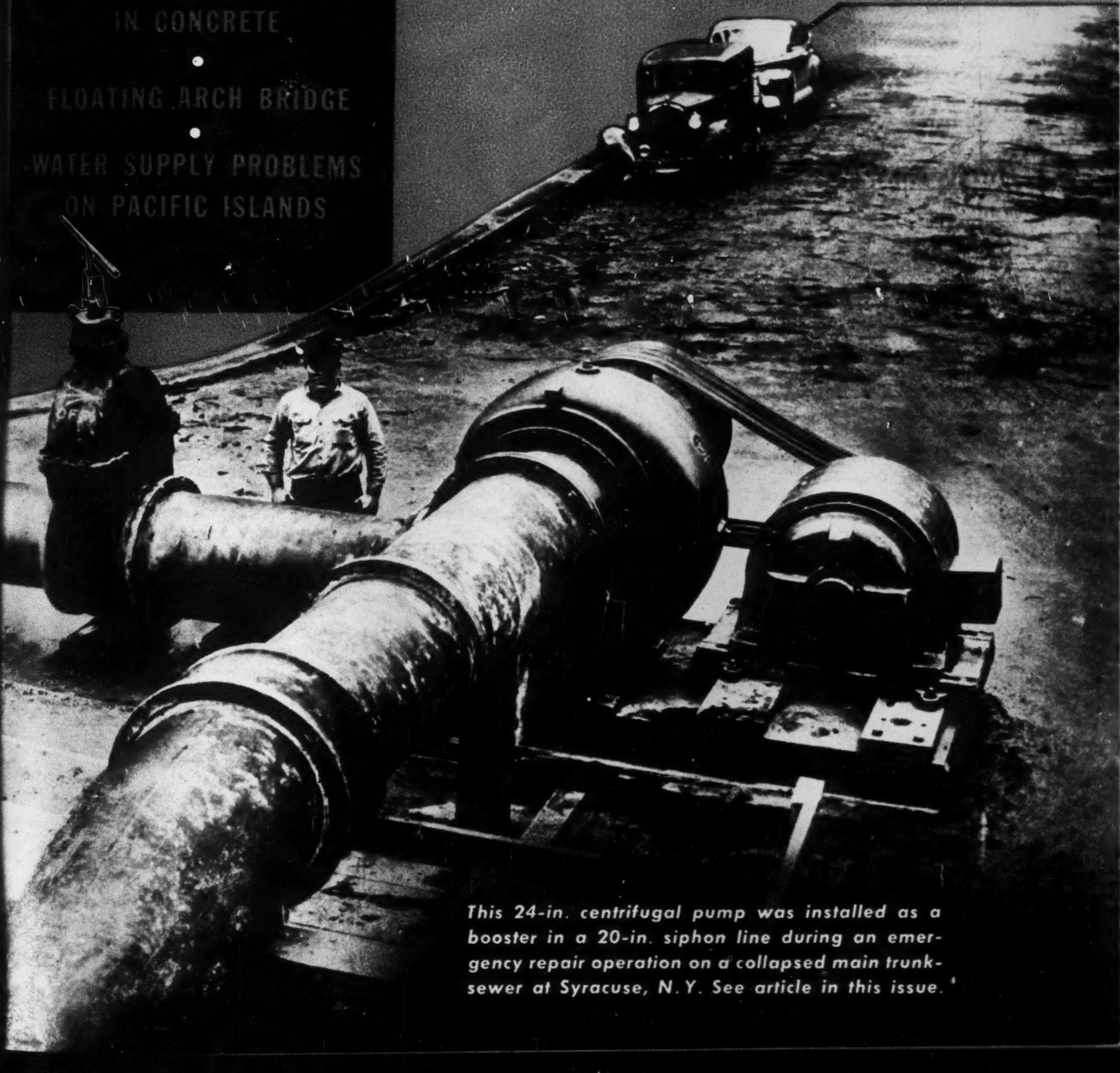
ENGINEERING NEWS-RECORD

AUGUST 9, 1945

In This Issue

- CORAL AS AN AGGREGATE IN CONCRETE
- FLOATING ARCH BRIDGE
- WATER SUPPLY PROBLEMS ON PACIFIC ISLANDS



This 24-in. centrifugal pump was installed as a booster in a 20-in. siphon line during an emergency repair operation on a collapsed main trunk-sewer at Syracuse, N.Y. See article in this issue.

This plant COMES UP with a proven answer to a common maintenance problem

BYERS WROUGHT IRON

In the many engineering projects where a stack is required, the engineer's selection of material has far-reaching effects, and so the proper choice is all-important. Under such conditions, it is helpful to see how the other fellow has handled a similar problem. A good example of wide-spread practice is given by this stack, 6'6" in diameter and 100 feet high, shown during erection. Intent on getting maximum life, the engineers used Byers Wrought Iron, which has an impressive record in stack service.

The varying degree of corrosion encountered makes it impossible to say with assurance how long any individual stack will last. But in any application where an unlined metal stack can be properly used, correct design and correct materials can definitely make it last longer. And the weight of the evidence indicates that the "correct" material is generally wrought iron.

This letter from a user reports a typical experience. He wrote, ". . . received the parts of two smokestacks from you in 1936. These plates were installed on the upper half of two of our stacks at that time. They have been in service continuously and apparently are in good enough condition to last several years longer. During the time that these stacks have been in service, we installed stacks manufactured from common sheets which have had to be replaced, replacement being due either to condition of the gases or temperature or both."

The acids formed when carbon and sulfur compounds are absorbed by moisture will attack any commercial metal used for stacks. It is wrought iron's unusual defense, which is due to its unusual structure, that gives it durability. Tiny fibers of glass-like silicate slag, threaded through the main body of high-purity iron, halt and deflect corrosive attack, and so discourage pitting. Further, these fibers help anchor the initial protective film, which shields the underlying metal.

A review of the corrosion problems ordinarily encountered i stacks, and details of a number o wrought iron installations, ar given in our bulletin, "Wroug Iron for Flue Gas Conductors an Coal Handling Equipment." W will gladly send you a copy o request.

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WALDO G. BOWMAN, *Editor* **ALBERT E. PAXTON, *Manager***

Vol. 135 AUGUST 9, 1945 No. 6

COMING NEXT

- Good drainage, planting of well-selected grasses, and proper fertilization has proved the most economical means of maintaining large unpaved areas of airports free from dust, mud and soil corrosion. In the Aug. 23 issue, types of grasses best suited to various sections of the country and methods of planting will be outlined. Other means of protection for unpaved areas, in those sections where grasses will not grow, are also described.

- In demolition work at Camp Hale, Colo., the first big cantonment to be dismantled, the Army Engineers, through careful planning and efficient operations, are setting a pattern for other such projects to come. Every piece of material and all equipment from the 1,070 buildings are being salvaged with German prisoner-of-war labor for future use at other military establishments. Methods used will be described in the Aug. 23 issue.

- Effect of moisture on compacted soils is the subject of an article in the Aug. 23 issue, which will be of special interest to highway engineers. Experiments show that road and runway surfaces fail largely because of poor protection for the clay subsoil from subsequent changes in moisture content; and failure to properly consolidate the soil into an integral structure.

LOOKING AHEAD

- Building B-29 plane bases on Tinian Island, with multiple runways 8,500 ft. long and 500 ft. wide, required removal of 10,000,000 cu. yd. of coral for fills—in some places more than 40 ft. deep. New developments in field methods and administrative control were worked out to fit the unusual character of this enormous project. Field forces never had to wait on engineering details and all assigned dates for completion were met or bettered. Construction procedures will be outlined in an early issue.

- Special equipment for cleaning, tar-coating and wrapping pipe in the field after welding; unsupported spans up to 420 ft. long across canyons, and a narrow sheepsfoot roller to compact trench backfill were unusual features on a natural gas pipeline project in California. The pipeline, 16 and 18 in. in diameter of welded steel, will be described in an early issue.

PAGE

The Week in Engineering and Construction 87
Comment and Discussion 92
Editorials 94
A Sewer Repair Race Against Time 96
Design of Rectangular Steel Tanks .... L. B. VANDERBILT 102
Seattle Freight Pier Has Modern Details 104
Engineers Right to Interpret Contract Upheld 107
Water Supply on Pacific Islands .... J. L. SHERILL 108
Triaxial Testing Machine .... R. F. BLANKS AND D. McHENRY 113
FPHA Housing Control Increased 115
Coral—A Good Aggregate in Concrete .... J. R. PERRY 116
Floating Concrete Arch Bridge 123
Demolition of Tall Timber Masts .... H. W. BRESSLER 125
From Field and Office 126
Book Notes and Reviews 127
Unit Prices 130
Material Prices 132
Elections and Activities 138
Men and Jobs 140
New Aids to the Constructor 154
Manufacturers' Publications 150
Construction Reports 215

Number of copies of this issue printed 37,497

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Due to the paper shortage, no index for volume No. 134 (Jan.-July, 1945) will be issued except to subscribers who ask for it. If you want a copy of the index please send in the coupon below.

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New Construction in July

INCREASED ACTIVITY in civil engineering construction in the past two months compared with that for the corresponding months in 1944 has brought the 1945 seven-month construction volume to $1,047,139,000, within 0.3 percent of that reported for the period last year. The current month's total, $170,984,000, tops the July 1944 total by 8 percent and follows the 51 percent increase recorded for June 1945 over the June 1944 figure.

The July construction total, though above last year, is 10 percent below the preceding month's volume. Private construction decreases 36 percent from a month ago, but public work is up 3 percent as a result of the 14 percent climb in state and municipal volume. Federal volume is down 1 percent from June 1945.

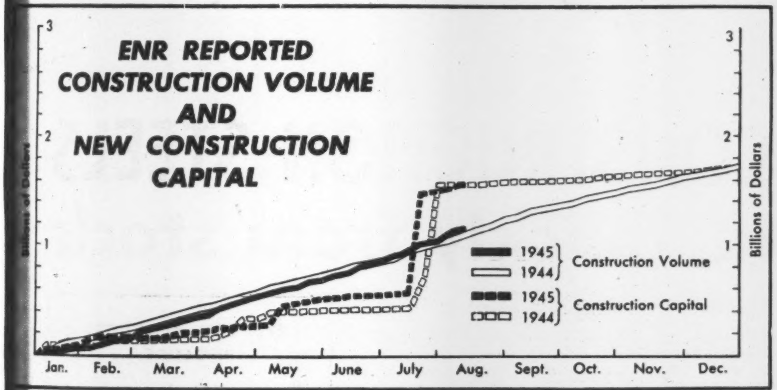
Both private and public work gain over their respective July 1944 totals, private climbing 9 percent and public 7 percent. The 64 percent rise in state and municipal volume offsets the 8 percent decline in federal work and is responsible for the public gain over a year ago.

The July construction volume brings the 1945 total to $1,047,139,000, a figure 0.3 percent below the $1,050,391,000 for the seven-month period in 1944. Private construction, $298,649,000, is 15 percent higher than a year ago, but public construction, $748,490,000, is 8 percent lower. The 15 percent decrease in federal volume—from $675,721,000 last year to $574,872,000 for 1945—is the factor behind the lower public total, as state and municipal construction, $173,618,000, is 29 percent above the seven-month 1944 total.

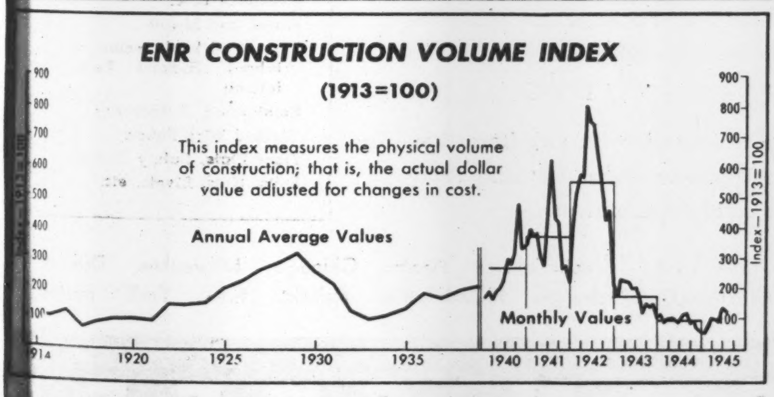
New capital for construction purposes for July totals $945,949,000, a volume 15 percent under the $1,111,014,000 reported in July 1944. The month's new financing is made up of $39,896,000 in state and municipal bond sales, $10,738,000 in corporate security issues, $2,000,000 in RFC loans for industrial construction, $60,000,000 in REA loans for rural electrification, $79,000,000 in federal-aid highway construction, and $754,315,000 in federal appropriations for military and departmental construction.

New construction financing for 1945 to date totals $1,485,700,000, a volume 4 percent below the $1,554,291,000 for the seven-month period a year ago. Of the 1945 total, $316,775,000 is in private investment, 110 percent above last year; $163,600,000 is in federal funds for non-federal construction, 17 percent above last year; and $1,005,325,000 in federal funds for federal construction, 20 percent below the seven-month 1944 total.

(*See Volume Table, page* 85)



ENR REPORTED CONSTRUCTION VOLUME AND NEW CONSTRUCTION CAPITAL

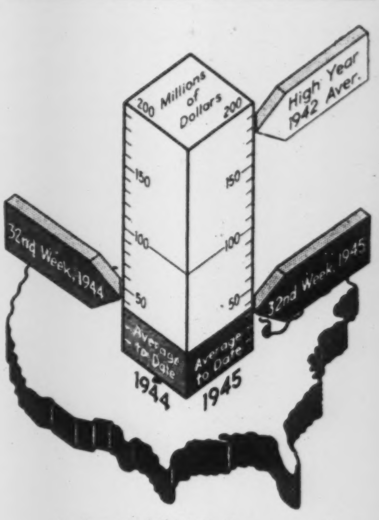


ENR CONSTRUCTION VOLUME INDEX

(1913=100)

This index measures the physical volume of construction; that is, the actual dollar value adjusted for changes in cost.

CONSTRUCTION ACTIVITY



As Reported This Week to . . .
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only
(Thousands of Dollars)

	Week of Aug. 9 1945	Cumulative 1945 (32 wk.)	Cumulative 1944 (32 wk.)
Federal	$8,637	$616,001	$715,364
State & Munic.	4,908	191,064	149,870
Total Public..	$13,545	$807,065	$865,234
Total Private.	16,639	346,609	256,482
U. S. Total...	**$30,184**	**$1,153,674**	**$1,121,716**

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Type of Work	Dollar Volume (Thousands) This Week	Cumulative 1945 (32 wk.)	Cumulative 1944 (32 wk.)
Waterworks	$641	$29,557	$19,228
Sewerage	1,546	19,333	18,361
Bridges	204	20,609	9,006
Highways	2,415	133,720	131,851
Earthwork, Waterways	1,142	28,304	39,763
Buildings, Public.	4,759	378,649	389,951
Industrial	11,280	226,122	111,078
Commercial ...	3,533	72,417	106,270
Unclassified	4,664	244,963	296,208

NOTE: Minimum size projects included are: Waterworks and waterway projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1945 (32 wk.)	Cumulative 1944 (32 wk.)
NON-FEDERAL	$500,764	$316,499
Corporate Securities.	91,408	86,845
State and Municipal.	245,756	90,194
RFC Loans	24,600	56,460
REA Loans	60,000	20,000
Fed. Aid, Highway..	79,000	63,000
FEDERAL	$1,014,412	$1,263,800
Total Capital	**$1,515,176**	**$1,580,299**

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost..	Aug. '45	309.08	148.57
Building Cost	Aug. '45	239.94	129.70
Volume	July '45	119	52

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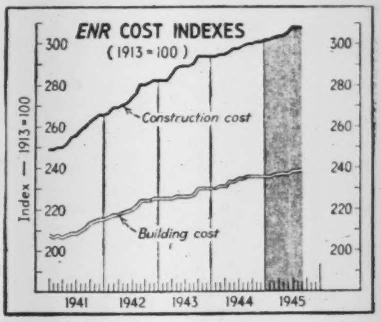
AUGUST CONSTRUCTION BUSINESS REPORT

ENR CONSTRUCTION VOLUME AND NEW PRODUCTIVE CAPITAL

(,000 omitted)	July 1944 (4 wk.)	July 1945 (4 wk.)	% Change	Seven Months 1944 (30 wk.)	Seven Months 1945 (30 wk.)	% Change
Total U. S. Construction	$158,561	$170,984	+8.0	$1,050,391	$1,047,139	—0.3
Private Construction	38,293	41,794	+9.0	239,774	298,649	+25.0
Public Construction	120,268	129,190	+7.0	810,617	748,490	−8.0
Federal	94,808	87,566	−8.0	675,721	574,872	−15.0
Total New Productive Capital	$1,111,014	$945,949	−15.0	$1,554,291	$1,485,700	−4.0
Private Investment	9,150	50,634	+454.0	151,031	316,775	+110.0
Federal (non-federal work)	83,330	141,000	+69.0	139,460	163,600	+17.0
Federal (federal work)	1,018,534	754,315	−26.0	1,263,800	1,005,325	−20.0
ENR Construction Volume Index, 1913 = 100	114	119	+4.0	102*	98*	−4.0

** Seven-month average.*



CONSTRUCTION COSTS....WAGE RATES....MATERIAL PRICES

	August 1944	August 1945	% Change	Change July to August 1944 July	1944 Aug.	%	1945 July	1945 Aug.	%
ENR Construction Cost Index, 1913 = 100‡	300.42	309.08	+2.9	299.94	300.42	+0.2	308.99	309.08	†
ENR Building Cost Index, 1913 = 100‡	236.09	239.94	+1.6	235.55	236.09	+0.2	239.64	239.94	+0.1

‡ Does not reflect increased costs due to overtime, lower labor efficiency, delivery delays, etc.

ENR 20-CITIES' AVERAGE

	August 1944	August 1945	% Change	1944 July	1944 Aug.	%	1945 July	1945 Aug.	%
Common Labor	$0.882	$0.916	+3.9	$0.882	$0.882	0	$0.916	$0.916	0
Skilled Labor (Av. 3 trades)	1.639	1.668	+1.8	1.638	1.639	+0.1	1.665	1.668	+0.2
Bricklayers	1.739	1.770	+1.8	1.736	1.739	+0.2	1.770	1.770	0
Structural Ironworkers	1.694	1.720	+1.5	1.694	1.694	0	1.716	1.720	+0.2
Carpenters	1.484	1.515	+2.1	1.484	1.484	0	1.510	1.515	+0.3
Cement, per bbl.	$2.67	$2.75	+3.0	$2.66	$2.67	+0.4	$2.74	$2.75	+0.4
Reinforcing steel, cwt.	2.79	2.79	0	2.80	2.79	−0.4	2.79	2.79	0
Structural steel, base	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.23	1.24	+0.8	1.23	1.23	0	1.24	1.24	0
Lumber, Fir, 2x4, per M ft.	54.58	55.63	+1.9	54.28	54.58	+0.6	55.87	55.63	−0.4
Lumber, Pine, 2x4 per M ft.	53.68	53.84	+0.3	53.09	53.68	+1.1	53.44	53.84	+0.7
Common brick, per M	16.52	18.78	+13.7	16.52	16.52	0	18.51	18.78	+1.5
Ready-mixed concrete, c.y.	7.44	7.66	+3.0	7.43	7.44	+0.1	7.58	7.66	+1.1
Struct. clay tile, 3x12x12	80.48	85.07	+5.7	80.48	80.48	0	84.75	85.07	+0.4
Paving asphalt, cars, ton	15.40	15.48	+0.5	15.40	15.40	0	15.48	15.48	0

† Less than .05 percent change.

ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	Construction Cost 1926	Building Cost 1913	Building Cost 1926	Volume '13	Volume '26
Aug., 1945	309.08	148.57	239.94	129.70	...	..
July, 1945	308.99	148.53	239.64	129.54	119	52
June, 1945	308.99	148.53	239.37	129.40	133	58
May, 1945	307.43	147.78	238.46	128.90	93	41
April, 1945	306.43	147.30	238.46	128.90	99	43
Mar., 1945	304.50	146.37	237.85	128.57	103	45
Feb., 1945	303.70	145.99	237.71	128.50	78	34
Jan., 1945	302.50	145.41	236.51	127.85	63	28
Dec., 1944	302.30	145.32	236.51	127.85	66	29
Nov., 1944	301.09	144.73	236.10	127.63	74	33
Oct., 1944	301.06	144.72	236.00	127.57	91	40
Sept., 1944	300.46	144.43	236.00	127.57	85	37
Aug., 1944	300.42	144.41	236.09	127.62	121	53
July, 1944	299.94	144.18	235.55	127.33	114	50
1944 (Av.)	298.64	143.59	234.73	126.89	96	42
1943 (Av.)	289.95	139.38	228.75	123.66	176	77
1942 (Av.)	276.31	132.82	222.39	120.22	553	243
1941 (Av.)	257.84	123.95	211.46	114.32	375	164

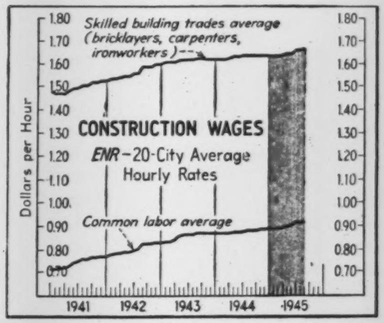
MATERIAL SHIPMENTS....BUILDING PERMITS

	July 1944	July 1945	% Change	June 1945	% Change June-July
Steel (% operating capacity) A. I. S. I.	95.4	89.4	−6.3	90.4	—1.1

	June 1944	June 1945	% Change	Six Months 1944	Six Months 1945	% Change
Fabricated structural steel, tons, A. I. S. C.	43,000	55,884	+29.9	257,598	333,249	+29.5
Cement, thous. bbl., U. S. B. of M.	......	......	......	......	......	......
Building Permits, 215 cities, Dun & Bradstreet (,000 omitted)	$58,179	$82,803	+42.3	$308,405	$404,330	+31.1

COST OF LIVING INDEX .... CIVIL NON-AGRICULTURAL EMPLOYMENT

	June 1944	June 1945	% Change	May 1945	% Change May-June
Cost of Living Index, N. I. C. B.	104.5	106.9	+2.3	106.2	+0.7
Rent (Housing) Index, N. I. C. B.	90.8	91.0	+0.2	91.0	0
Total Employment (est.), thous., B. L. S.	......	......	......	......	......
Constr. Employment (est.), thous., B. L. S.	......	......	......	......	......



ENGINEERING CONSTRUCTION CONTRACTS — ENGINEERING NEWS-RECORD — JULY, 1945

Engineering News-Record *reports continental U. S. Construction projects of the following minimum costs—waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks—Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States July 1945	United States Seven Months 1945	United States Seven Months 1944	Canada
Waterworks	45	1,541	996	932	1,123	678	**5,315**	**25,112**	17,479	244
Sewerage	118	120	403	....	1,049	583	**2,273**	**16,896**	16,952	1,303
Bridges, public	81	631	2,343	549	2,930	102	**6,636**	**15,889**	6,655	125
Earthwork and waterways	71	57	2,291	721	225	302	**3,667**	**23,538**	34,818	77
Streets and roads	766	3,494	6,005	8,449	5,659	3,054	**27,427**	**121,639**	120,024	2,982
Buildings, public	1,327	5,715	4,131	4,056	6,470	24,795	**46,494**	**352,221**	372,330	7,115
Unclassified, public	335	4,879	12,034	540	8,499	11,091	**37,378**	**193,195**	242,359	30
Total public	**2,743**	**16,437**	**28,203**	**15,247**	**25,955**	**40,605**	**129,190**	**748,490**	**810,617**	**11,876**
Federal government (included in above classifications)	**1,672**	**9,186**	**19,032**	**4,432**	15,567	**37,677**	**87,566**	**574,872**	675,721	....
Private										
Bridges, private	....	....	....	....	....	75	75	3,706	1,325	....
Industrial buildings	4,364	3,321	2,977	5,766	2,403	2,626	21,457	202,208	105,770	7,590
Commercial buildings	2,367	4,494	750	1,810	1,170	3,960	14,551	58,841	98,967	3,468
Unclassified, private	120	825	1,160	1,229	2,099	278	5,711	33,894	33,712	....
Total private	**6,851**	**8,640**	**4,887**	**8,805**	**5,672**	**6,939**	**41,794**	**298,649**	**239,774**	**11,058**
Total Engineering Construction:										
uly, 1945—4 weeks	**9,594**	**25,077**	**33,090**	**24,052**	**31,627**	**47,544**	**170,984**	....	....	**22,934**
une, 1945—4 weeks	11,012	28,618	17,080	43,096	26,784	64,024	190,614	....	....	11,121
uly, 1944—4 weeks	4,705	28,940	28,434	20,442	25,063	50,977	158,561	....	....	13,845
even Months—1945	**47,512**	**145,462**	**184,913**	**162,192**	**229,768**	**277,292**	....	**1,047,139**	....	**79,138**
even Months—1944	29,749	163,452	184,017	132,111	164,188	376,874	....	....	1,050,391	58,517

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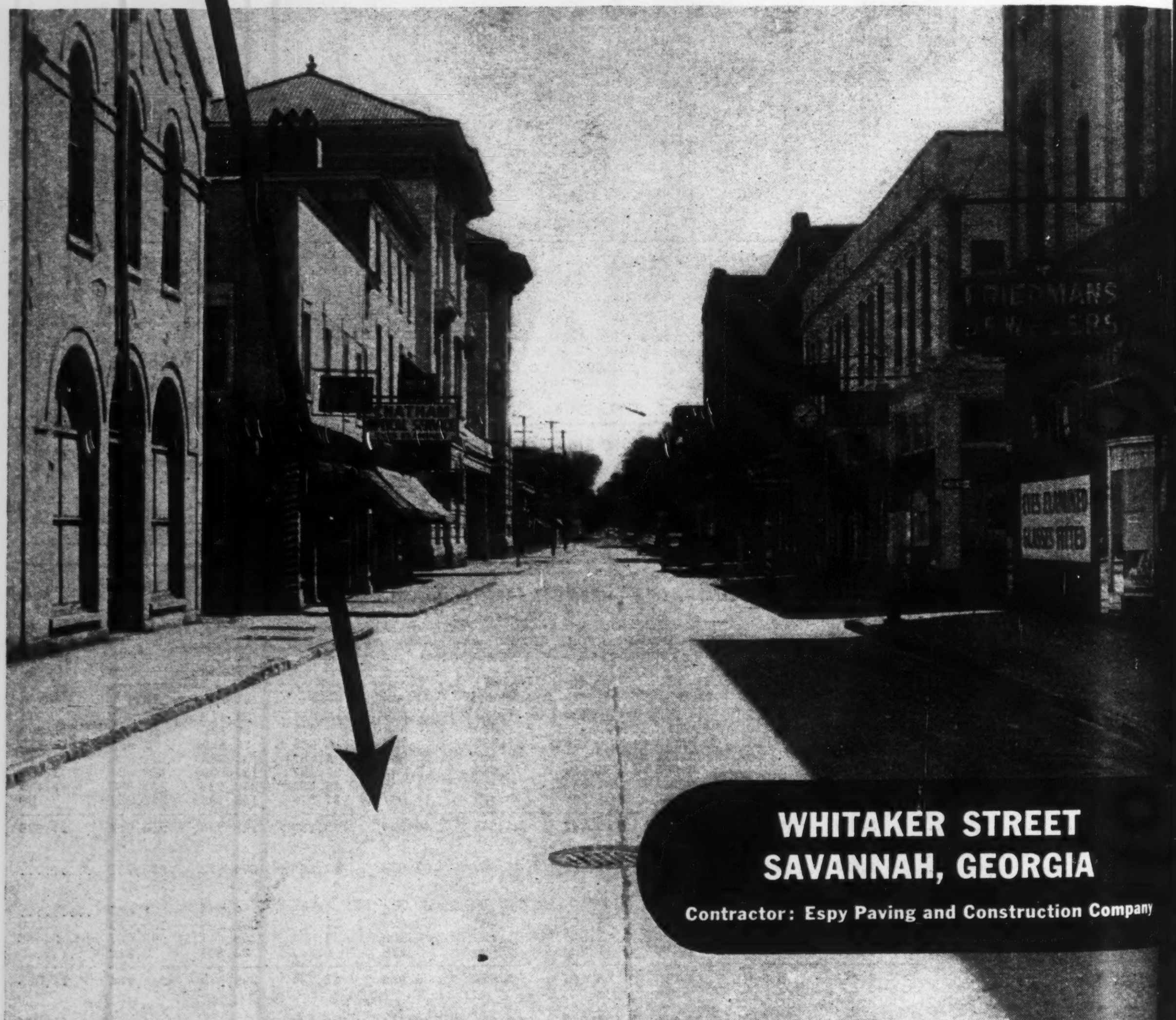
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Contractor: Espy Paving and Construction Company

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • AUGUST 9, 1945 • VOLUME 135 • NUMBER 6

Industry ready to expend $6 billion for new work

Commerce Department survey shows manufacturers, railroads, utilities prepared to spend huge sums on expansions, extension of services, and new equipment.

During the federal fiscal year that began on July 1, manufacturers plan to spend $4,500,000,000 for plant expansions, alterations and necessary equipment, according to a Department of Commerce survey, while in the same period, railroads and utilities of the country plan to spend $1,500,000,000 on expansion of their facilities.

The Department report noted, however, that shortage of some building materials may hold up some of the work, although most of the necessary funds are readily available.

Distribution of work

Revealing plans for $800,000,000 of work, manufacturers of chemicals, rubber, petroleum and coal products plan the largest program. Producers of paper and allied products, and the printing, publishing and allied industries plan $530,000,000 worth of work. Firms producing tobacco and food and kindred products expect to spend $665,000,000.

Makers of transportation equipment, including those producing automobiles, have planned plant expansions and equipment installations expected to total $600,000,000;—producers of machinery, including electrical goods, have a $450,000,000 program, and $550,000,000 worth of work is programmed by textile, apparel, and leather products industries. The remainder of the 4.5 billion dollar program is made up as follows: Producers of lumber and basic timber products, $160,000,000; stone, clay and glass industries, $200,000,000; manufacturers of iron and steel and related products, $340,000,000; producers of nonferrous metals and their products, $130,000,000; and miscellaneous industries accounting for $75,000,000.

The Department of Commerce report does not segregate estimates for construction and for equipment, but from past records of industrial construction it can be estimated that construction work should account for about $1,816,000,000 of the 4.5 billion total reported for industries other than rails and utilities.

The study emphasizes that manufacturers plan to finance nearly 75 percent of the total planned outlays from cash resources on hand. This appraisal is considered as being on the conservative side.

Railroad plans

Of the 1.5 billion dollar expansion program scheduled by the railroads and utilities, (which does not include outlays for repairs and maintenance), about $785,000,000, or over one-half of the program, will be done by the railroads. Of this latter total about 40 percent will go for construction and the other 60 percent for new equipment.

(*Continued on page* 88)

Constructors share credit for atomic bomb

Men who work in the realms of pure science take top precedence in current news of development of atomic power for use as an offensive weapon against Japan, but the nation's civil engineers—in and out of the Army—come in, certainly, for honorable mention.

It was the engineer—with the builder and the contractor—who succeeded in putting together a jigsaw-puzzle of plans into immense plants that could do the job the scientists wanted. Among those to whom credit for this part of the job should go are:

The Manhattan District of the U. S. Army Engineers, which was established to handle only the atomic development, and is headed by Maj. Gen. Leslie R. Groves to whom Secretary of War Stimson gives highest credit and praise for the success of the project.

One of the two plants at the 59,000-acre Clinton Engineer Works, near Knoxville, Tenn., was designed by M. W. Kellogg Co., built by J. A. Jones Co. and is operated by Union Carbide & Carbon Co. The other plant at Clinton was designed and constructed by Stone & Webster Engineering Corp. and is operated by the Tennessee Eastman Co. Col. Kenneth D. Nichols is district engineer at the Tennessee plant. The 430,000-acre Hanford Engineer Works, near Pasco, Washington, was designed and constructed by E. I. duPont de Nemours under supervision of Col. F. T. Matthias.

News-Record construction figures conservative

Adhering to its policy of listing only such projects as can be definitely described and located, *Engineering News-Record* has been conservative in its reports of private construction plans, a comparison with the Department of Commerce survey of industrial construction plans shows.

Actual projects have been reported in *ENR* columns totalling $485,000,000—or 27 percent of the construction total in the Commerce survey.

"Unclassified" projects have been listed totalling $488,000,000—amounting to 48 percent of the railroad and utility total in the government report.

In a further breakdown of the survey at the head of this page, *ENR* statisticians reported that the construction total alone included in the overall figure would run approximately as follows: $1,816,000,000 for factory or industrial construction; $344,000,000 for railroad construction, and $700,000,000 for utility construction and equipment—this latter being too integral with construction to estimate separately. This gives an overall, purely construction total of $2,830,000,000.

President approves engineer work bills

A long list of measures of interest to the construction industry were enacted during the first session of the 79th Congress, which convened January 3 of this year and recessed August 1.

Included in the bills made law by the President's signature were several providing large amounts of money for war construction; a number dealing with postwar work, including one providing planning aid for local public works groups. In addition, the treaty with Mexico concerning distribution of water from the Rio Grande, Colorado, and Tijuana rivers was approved by the Senate without reservations, although that body gave its interpretation of certain terminology of the treaty (*ENR*, April 26, vol. p. 596).

A partial list of engineering laws passed during the first session, with the number of original bill being shown in parenthesis, follows:

Public Law No. 13 (H.R. 626) Authorizes 1.5 billion dollars for construction by U. S. Navy, including $986,000,000 for advance base construction (*ENR*, Feb. 8, 1945, vol., p. 164).

Law 14 (S. 35) Authorizes 291 rivers and harbors projects estimated to cost $382,000,000 (Breakdown in *ENR*, May 1, vol., p. 287).

Law 24 (H.R. 2126) Appropriates $112,450,000 for War Department civil function activities, including about $44,000,000 for river and harbor work, $24,000,000 for flood control in general, and $30,000,000 for flood control on Lower Mississippi (Details given in *ENR* Mar. 15 vol., p. 356).

Law 34, (H.R. 914) Grants consent of Congress to the states of Colorado and Kansas to enter into compact for division of Arkansas River water (*ENR*, April 19, vol. p. 55).

Law 40 (H.R. 2374) Deficiency bill for 1945 and supplemental bill for 1946. Appropriates 2.4 billion dollars, including $20,000,000 for Federal Works Agency for community facilities, $15,000,000 for Public Roads Administration for access roads, $8,000,000 for PRA for work on strategic highway network, $84,373,000 for National Housing Agency, and $114,300,000 to Navy Department for public works construction.

Law 49 (R.R. 1984) Independent offices appropriation bill. Appropriates among other things, $17,500,000 to Bureau of Community Facilities of FWA for planning advances to local public works groups. (*ENR*, May 10, vol. p. 675).

Law 52 (H.R. 2689) Department of Agriculture Appropriations Bill for fiscal year 1946. Includes: $4,418,000 for construction of forest roads, $1,500,000 for maintenance and reconstruction of forest highways, $1,063,000 for construction of experimental watersheds stations, and other facilities, and $1,165,066 for water conservation and utilization projects.

Law 62 (H.R. 2907) Naval appropriation bill for the fiscal year 1946. Provides 23.6 billion dollars for construction, including $228,000,000 for work in U. S. and $786,000,000 for advance base construction (*ENR*, May 24, vol. p. 733).

Law 63 (H.R. 533) Authorizes the Minnesota State Department of Highways to construct and operate a free highway bridge across the Mississippi River at Hastings, Minn.

Law 64 (H.R. 1184) Authorizes the Slater Branch Bridge and Road Club to construct and operate a free suspension bridge across the Tug Fork of the Big Sand River at Williamson, W. Va.

Law 65 (H.R. 1652) Grants the consent of Congress to the State of Louisiana to build and operate a free highway bridge across the Mississippi River at New Orleans.

Law 66 (H.R. 1659) Authorizes the Minnesota State Department of Highways to erect and maintain a bridge across the Pigeon River.

Law 71 (H. J. Res. 113) Grants Congressional consent to the amendment of the agreement between New York and Vermont regarding the creation of the Lake Champlain Bridge Commission.

Law 75 (S. 938) Provides $12,000,000 for emergency flood control work (*ENR*, May 24, vol. p. 732).

Law 103 (H.R. 3306) Appropriates $9,087,160 for construction work by District of Columbia for fiscal year 1946 (*ENR*, July 19, vol. p. 74).

Law 123 (H.R. 3024) $111,690,250 appropriation for Department of Interior for fiscal year 1946. Provides $17,275,000 for general construction, $9,783,500 for special construction account and $3,200,000 for Missouri River Basin planning (*ENR*, July 5, vol. p. 12).

Law 125 (H.R. 3278) Provides $30,000,000 additional Lanham Act funds for Federal Works Agency. Only small proportion for new construction, although in *ENR*, June 7, vol. p. 794 it was reported that major part was for this type of work.

Law 126 (H.R. 3550) Furnishes 21.5 billion dollars for War Department for fiscal year 1946. Includes $176,000,000 for construction work at military posts in this country, $540,000,000 for maintenance and operation of military facilities, and 2.6 billion dollars for purchasing equipment, including a large amount of construction machinery (*ENR*, July 5, vol. p. 2).

Law 132 (H.R. 3579) Second deficiency bill for 1945. Provides $20,000,000 of Lanham Act funds for Federal Works Agency for community facilities, and $8,906,000 to Army Engineers for flood control, and $6,504,600 to Corps for rivers and harbors work. Also makes available $75,000 to Department of Commerce for setting up new construction division (*ENR*, July 12, vol. p 20).

Law 145 (S. 454) Reenacts the act creating the Arkansas-Mississippi Bridge Commission and authorizes the commission to construct and operate a bridge across the Mississippi near Friar Point, Miss.

Law 147 (S. 527) Extends time for commencing construction of a bridge across the Saint Croix River near Hudson, Wis.

$6,000,000,000 building program

(Continued from preceding page)

Railroad work will be high in comparison with that of the decade of the 30's, but the total railroad program does not equal peak years.

Planned expenditures are 35 percent above 1944, three times the rate of 1939 and about double the average of 1937-40.

The western railroads expect to spend about $370,000,000, or almost half of the expansion outlay for all the lines. About one-half of the expenditure by the western roads is expected to be for construction and the remainder for new equipment. In the southern districts of the country, new roadways and structures are expected to absorb the greater part of the $155,000,000 program planned by those roads. In contrast, only about one-third of $260,000,000 expansion program planned by eastern railroads will be for construction, the remainder to go for purchase of equipment.

Large utilities program

During the year that began July 1 electric and gas companies plan outlays of over $700,000,000 for structures, improvements and various kinds of equipment.

Plans of electric utilities account for about three-fourths of the combined total, which would make this work about 25 percent above the 1939 level. The largest expenditures are planned for the East North Central power region, although proportionately the South Central region expects the largest percentage increases.

Gas line construction

Gas companies are planning outlays for expansion and new equipment that will be 70 percent above those of 1939. One reason given for the larger increase is enlargement of natural gas and gas pipeline systems. The largest amount in dollars and the greatest increase over 1939 is scheduled by the gas utilities for what the report calls the West South Central region. Outlays for this area comprise more than 25 percent of the total, considerably more than this region's share of anticipated revenues.

In financing these programs, utilities will place major reliance upon cash assets, including holdings of government securities. Over 60 percent of the outlays are expected to be financed from this source, which would still leave these cash assets well above the prewar amount, since at the end of 1944 the utilities had accumulated almost 1.25 billion dollars in cash assets, almost double the holding at the end of the year 1940.

Expansion of some sewage works proving troublesome and expensive

Los Angeles' continued use of Hyperion outfall subject of trial in November. Boston to spend $15 million on new facilities.

On opposite sides of the continent as well as deep in the heart of Texas the operation and construction of sewage disposal works is affecting the public temper and purse-strings. In California the state has decided to take action in November against Los Angeles and 88 other cities to enjoin the operation of the Hyperion outfall sewer, elimination of which will cost $21,000,000. Boston, meantime, has received state authorization to spend $15,000,000 for expansion of facilities.

And in Waco, Tex., the city commission has passed an ordinance providing that citizens who refuse to pay a sewer tax charge will be cut off from service by having their sewer connections filled with concrete.

Other cities where sewage disposal projects are being considered for early construction include Louisville, Ky.. Columbus and Toledo, Ohio.

Los Angeles' troubles

Los Angeles' prolonged sewage troubles were aired again in court recently when the State of California's injunction suit against the city was set for trial November 26.

Filed December 13, 1943, against Mayor Fletcher Bowron of Los Angeles and 88 other officials of Los Angeles and other cities, the state's suit seeks to enjoin use of the city's Hyperion outfall sewer which, it is claimed, has polluted Santa Monica Bay beaches.

The State Board of Health cancelled a permit for operation of the sewage treatment plant on May 20, 1942. The state has quarantined some 10 miles of beaches since April 3, 1943.

The injunction suit has been postponed repeatedly, but its threat of fines of $1,000 a day for continued operation of the Hyperion plant was emphasized by the attorney general's office. Presiding Judge Samuel R. Blake, of Los Angeles Superior Court, set the trial date after conferring with representatives of the various cities named.

Los Angeles City Attorney Ray L. Chesebro pointed out that the city voted a $10,000,000 bond issue April 3. (*ENR* April 12, vol. p. 542). The entire sewer rehabilitation program as recommended last year by the Boston consulting firm of Metcalf and Eddy will cost $21,000,000 (*ENR* June 29, 1944, vol. p. 921). The program envisions provision of a high degree treatment by means of an activated sludge process, with the effluent discharged a mile off the shore.

The Los Angeles City Council will begin public hearings July 30 on the advisability of enacting a service charge for $6,000,000 of the financing, and other cities are expected to contribute $5,000,000. Mr. Chesebro said Governor Earl Warren will call a special session of the legislature for next January, at which a proposed subvention from the state would be considered.

Action in Boston

The Massachusetts legislature has authorized the Boston Metropolitan District Commission to spend $15,000,000 for a large-scale expansion of sewage disposal facilities, including a sewage treatment plant at Nut Island, Quincy; extension of the north metropolitan relief sewer from East Boston to Deer Island; and a sewage treatment plant at Deer Island.

Other work includes installation of conduits, pumping stations and disposal plants along Alewife Brook in the cities of Cambridge. Medford. Belmont, Somerville and Arlington.

The commission plans completion of five projects before 1955 and is restricted against spending more than $4,450,000 during the present fiscal year. which began July 1.

Waco uses sewer tax

Citizens who refuse to pay sewer taxes in Waco, Texas, will have their service cut off by the city's promptly digging down to the delinquents' sewer pipes and filling them with concrete, according to W. C. Torrence, city manager. Service will be restored only after payment of the tax owned, and all expenses incident to re-connecting the sewer.

Mr. Torrence's statement was issued after the City Commission passed an ordinance providing that funds collected in the city sewer tax could be used to finance operation, maintenance and extension of the municipal sewer system. The ordinance also provided that all moneys not required for these purposes could be applied to principal, interest and service charges on Waco's sanitary sewer bonds.

Immediate start on engineering plans for a $7,500,000 sewage disposal plant and the necessary intercepting network of sewers has been recommended by the board of directors of the Area Development Association of Louisville, Ky.

Waterworks improvement started in three cities

Progress in the enlargement of water supply facilities is reported in Akron, O., San Diego, Cal., and Houston, Texas. Akron was allocated $32,000 of Federal Works Agency funds on July 30 to blueprint plans for the expansion and modernization of its 30-year-old Cuyahoga River water treatment plant and pumping station at Kent, Ohio.

The City Planning Commission estimated that the project would cost $877,000, Baird Snyder, Acting Federal Works Administrator, said. He added that it has priority No. 2 on the city's list of 14 post-war projects.

The present treatment plant and pumping station were designed and built in 1914, when the population of Akron was less than 100,000. It was enlarged in 1920, when the population had risen to 206,000. With only slight additions, it is now serving a population of some 300,000.

San Diego studies start

Instructions to go ahead with studies of San Diego's water poblem were given J. L. Burkholder, general manager and chief engineer, by the San Diego, Calif., County Water Authority recently, following Mr. Burkholder's estimate that such a program would cost $100,000. Mr. Burkholder was reported as saying that the commission would cooperate with government engineers in planning and construction of an aqueduct to bring water to the area; and negotiate with the Bureau of Reclamation, which gives Colorado River water rights to San Diego city and county and with the Metropolitan Water District to bring about a solution of the area's water needs. It will give an opinion as to the better of two proposed means of bringing in water—the All-American Canal or the Colorado River Aqueduct.

The Lane-Texas Co. is preparing to drill six new water wells southwest of Houston, Tex., for the city's water system. The wells will be gravel-walled, and cost $37,000 each, according to J. B. Dannenbaum, engineer, serving under Jack Fugate, Houston's designing engineer.

Houston's first deep gravel-walled wells were drilled in 1917 and produced 2,000 gpm. compared to a previous peak of 500 to 600 gpm. by old type wells. W. W. Horner, of St. Louis, is consulting engineer on Houston's water supply problem.

U. S. says Permutit Co. headed cartel

Charging violation of the Sherman anti-trust laws because of an alleged world-wide cartel in the water-conditioning industry, T. C. Clark, U. S. Attorney-General, filed an action in the United States District Court in New York last week against the Permutit Co. of New York City and its board chairman, W. Spencer Robertson.

The Permutit Co. is accused—with five other companies having headquarters in Britain, France, Germany, Belgium and Spain—of dividing the world into six areas of operation within which each of the member companies would have the exclusive right to manufacture and sell the patented water-purifying equipment and processes controlled by the cartel.

This, it is alleged, hindered domestic and foreign competition, and permitted each of the member firms to fix prices in an exclusive area at its discretion.

The present action, according to Wendell Berge, Assistant Attorney General in charge of the anti-trust division of the Attorney General's office, is important because the water-purifying equipment is used by municipalities and by chemical firms, steamships, railroads, dye, canning and a host of other industries. Although there are other water-conditioning processes for specific purposes, the equipment of the Permutit combination was the most widely used.

One of the cartel's patents, said Mr. Berge, is the "desalter" used by the Army and Navy as standard equipment in life rafts for transformation of seawater into potable water.

Permanent dissolution of all agreements between the American company and foreign members of the cartel is asked by the government.

The government also demands that the patented equipment being sold under the "Permutit" trademark be made available free of royalties to all firms desiring to manufacture and distribute it, and that the use of the trademark be prohibited after a reasonable period.

The foreign companies, while not made defendants in the present proceedings, were named as co-conspirators. They are: The Permutit Co., Ltd., of London; Permutit Aktiengesellschaft, of Berlin; Societe Anonyme Etablissements Phillips and Pain, of Paris; Societe Anonyome Etablissements Phillips and Pain, of Brussels; and Purificadores De Aqua, S.A., of Barcelona.

Invited by *Engineering News-Record* to make a statement, H. W. Foulds, president of the Permutit Co., said that the company did not wish to comment on the action at this time.

Rapid transit assured to Boston's airport

Better rapid transit service is promised for East Boston and the Logan Airport as result of the passage of a bill, providing for construction of a $5,000,000 extension of the Boston rapid transit system from Maverick Square to Day Square with a transfer station at the airport.

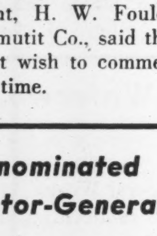
According to the Massachusetts State Planning Board, this will be the only major airfield in the country with direct rapid transit connection. The service will place the airport within 10 min. of downtown Boston for a ten cent fare.

From a station on the edge of the airport shuttle buses will operate through the airport administrative area and will serve hangars, shops and other facilities. The transit line will be carried beyond the airport to Day Square where a transfer station will be built to accommodate trolley cars.

Cost of the extension will be met by a City of Boston bond issue with an annual rental to be paid by the Boston Elevated Railway. Construction will be done by the Transit Department.

Gen. Sultan nominated Army Inspector-General

President Truman has sent to the Senate the nomination of Lt. Gen. Daniel I. Sultan for the post of Inspector General of the Army.



Gen. Sultan, former engineer commissioner of the District of Columbia, has commanded the India-Burma theatre for the army since last October, when the China-Burma-India theatre was split after General Joseph W. Stilwell's return home.

Now 59, Gen. Sultan, was a West Point graduate in 1907. Subsequently, he became commanding general of the 8th Army Corps, serving until 1943 when he was shifted to the Far East. He succeeds Maj. Gen. Virgil L. Peterson, who recently became director of personnel of the U. S. Army Service Forces.

Special committee speeds reconversion

Creation of a special inter-agency committee to speed reconversion of the construction industry to peace-time operation was announced late last week by John W. Snyder, director of the Office of War Mobilization and Reconversion. Hugh Potter, Houston, Texas, lawyer, will head the new group.

The committee will undertake to expedite and promote a rapidly expanding construction industry; try to break bottlenecks which are throttling attempts to relieve the acute housing shortage and to absorb its share of the expected slack in employment.

Specifically, four objectives are planned: (1) Review programs and plans of the various federal agencies with respect to construction activity; (2) Coordinate policies and procedures of these agencies so as to facilitate reconversion of industry consistent with continued needs of the war; (3) Determine impediments to the speedy resumption of construction activity, and (4) Make recommendations to the director of the Office of War Mobilization and Reconversion for appropriate action.

The committee holds its first meeting late this week in Washington, when it is hoped that permanent members, representing 11 agencies will be named. These agencies are: Office of War Mobilization and Reconversion, Office of Economic Stabilization, War Production Board, Office of Price Administration, National Housing Agency, War Labor Board, Federal Works Agency, War Manpower Commission, Department of Commerce, Department of Labor, and the smaller war plant corporations.

It is to be noted that Departments of Interior, Agriculture, War and Navy have not been requested to name representatives on the committee. These departments were left off the list in the desire to make all agencies represented those most interested in the "week-to-week" problems of reconversion. However, by means of sub-committees it is expected that all of the normal peacetime agencies will be given a chance to tell of their planning programs and make known their particular problems.

Potter, the committee's chairman, although not an engineer, is president of the River Oaks Corporation, which developed an area of Houston, Texas, frequently mentioned for its use of city planning and land development practices. He is also a past president of the National Association of Real Estate Boards and of the Urban Land Institute.

Contracts let for flood control project

Contracts for work totalling $5,296,0 for the Lytle-Cajon Creeks emerncy flood control project in San ernardino County, Cal., were awarded rly this month by Col. R. W. Putm, U. S. District Engineer at Los ngeles. An $8 million appropriation r the work was recently requested NR Aug. 20, 1945, vol. p. 130).

Levees and by-pass construction will executed by Winston Bros. Co., Los ngeles; Utah Construction Co., of n Francisco and Vinell Co., of Almbra. A $2,528,000 joint contract the Lytle Creek channel intake and tlet structure went to Bressi and vanda Constructors, Inc., of Los Anles and the Macco Const. Co., Clearter, Cal.

The project is to be completed by n. 15, to check floodwaters which nace three transcontinental railds and many highways. Steel and pply contracts totalling $3,091,000 re awarded earlier this year.

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49th CB decommissioned holds impressive record

Decommissioned at Guam July 25, er 31 months of life that included two rs of duty overseas, the 49th Naval nstruction Battalion has been broken for replacements to other outfits.

Organized Dec. 18, 1942, the 49th first assigned to duty at Bermuda, isting base contractors in finishing nd construction projects and workon repair of 250 ships bound for African invasion.

The 49th arrived at Guam Oct. 24 of year, and in succeeding months took ve part in building Guam into a ion for Pacific-based forces. Among er projects are "Cincpac" advance dquarters, including water and er installations; a big power plant transmission lines; miles of coralpaved roads; a base hospital. gars and other facilities at the y's depot field. The battalion deed from straight construction on y occasions. A notable example when a hangar-steel erection crew over the job of straightening bent wing spars on two B-29 bombers. ommdr. Marshall D. Barnett, fory a building contractor at Dallas, has commanded the 49th ever its inception. Present executive r is Lt. Comdr. Dwight S. Vickers, formerly an engineer with U. S. Soil Conservation Service at oln, Nebr.

OBITUARY

MacDuff D. Bell, 50, chief civilian district engineer for the War Department office at Syracuse, N. Y., and his son Joseph, 10, were drowned August 1 when a boat from which the two were fishing sank in the Otselic River near Whitney Point, N. Y. A native of Mississippi, Mr. Bell held engineering assignments at Memphis, Tenn.; Zanesville, O.; Florence, Ala.; Chattanooga, Tenn.; and at Binghamton, N. Y. He had recently been awarded a certificate and War Department Service Emblem for "meritorious service".

Lt. Col. J. R. Morrison, a civil engineering graduate of Iowa State College and leader of an armored engineer battalion, was killed in action in Germany April 26, 1945.

A. J. T. Taylor, 57, designer of the Lions' Gate Bridge across the entrance to Vaucouver harbor, B. C., and builder of many other important structures in his native British Columbia, died recently at New York City, N. Y.

Charles E. Torrance, 60, consulting engineer, died July 22 at Rochester, N. Y.

Norwood M. Lash, 73, former chief engineer for the Bell Telephone Company of Canada, died suddenly July 25 at Little Rock, Ark.

Marius Dufresne, 62, founder and president of the Dufresne Construction company and a prominent Quebec engineer, was killed in an accident July 26th, when a 25-ft. pole being removed from the river-bed near the Duplessis Belair bridge at Ste. Rose, snapped and fell on him. He had been surveying the progress being made on a new bridge there.

Walter M. Jones-Williams, 81, consulting engineer of the Alabama College and formerly engineering superintendent of buildings and grounds of the college, died at Montevallo, Ala., recently. A native of South Wales, U. K., he was a member of the college staff for 39 years.

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Banks and city plan housing project

A $7,600,000 medium-rental housing development will be constructed in northern Manhattan as a result of an agreement between the City of New York and representatives of 7 savings banks. The city will condemn the site for the redevelopment company, which will act as an agent of the banks. All cost of the work will be paid by the company, but all improvements to the site exceeding in value the present assessed valuation of the property will be tax exempt for 25 years.

Seven 12-story and seven 14-story buildings, containing about 1,500 apartments to house 5,000 persons, comprise the development, which will be called Colonial Village. Eggers & Higgins of New York are architects for the project.

JOBS OF THE WEEK

HOUSING, Bremerton, Wash.

Nelse Mortensen & Co., Seattle, lowest bidders for dormitory housing units, when Public Housing Authority, Seattle, opened bids at $1,145,000. Naramore, Bain, Brady & Johnson, Seattle, are the architects.

PLANT, Mount Royal, Que.

Angus Robertson, Ltd., Montreal, Que., has been awarded contract for 250x420-ft. plant by White Company, Ltd., Montreal. Estimated cost is $1,000,000. Ross & MacDonald, Montreal, are architects.

ROUND HOUSE, Bellevue, O.

New York, Chicago & St. Louis Railroad Co., J. C. Wallace, chief engineer, Cleveland, awarded contract for round house, shop and locker buildings, turntable with 18 stalls, relocating west bound freight yard to Alger-Rau, Inc., Cleveland. The estimated total cost is $1,600,000.

GALVANIZING WORKS, Middletown, O.

American Rolling Mills Co., Middletown, O., awarded contract for the construction of galvanizing plant, at East Works to F. H. McGraw Construction Co., Middletown, at estimated cost $1,200,000.

Note—Additional bidding and contract news on many projects large and small, including the above items, appear in the Construction News section beginning on page 215.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Central Testing Bureau Urged

Sir: Mr. A. J. Boase in "Building Codes" (*ENR* April 19) suggests that restrictive codes hinder progress. The 1941 Standard Building Code of the American Concrete Institute was written so as to allow designers as much freedom as possible and at the same time insure compliance. The writer believes that this code does allow freedom in design. Sec. 202 provides a load test. This is a reasonable test. But it requires one change to make it perfect. As proposed by the writer, the deflection under test should be limited to 1/720 of the span in all cases.

Engineers know that adequate stiffness is important for the proper functioning of structures. Deflections in steel beams are limited to 1/360 of the span on the theory that such a deflection is the limit allowable to avoid plaster cracks. Under certain circumstances, Sec. 202 of the A.C.I. Code will permit a deflection of 1/360 of the span. This is inadequate. It does not provide for the long time deflections which occur in reinforced concrete members due to flow or shrinkage of the concrete. True, the requirement for steel is at design load, whereas the A.C.I. Code formula applies to a test load. However, in most cases, the test load will not be far from the design load, and the deflection that is measured is that caused by the test.

A central Bureau of Tests should be established to serve the building industry. It should be independent, adequately endowed, staffed by competent technicians and scientists, and its findings should be accepted without question by all city building departments in the U. S. It could and probably would charge a reasonable fee for services rendered. No doubt the promoters of new materials and new structural systems would be delighted to pay a reasonable charge for such a service, if they knew that the bureau's findings would be accepted by building departments generally.

The present system, which requires that a separate investigation and approval shall be had before approval in each city, is utterly archaic and outmoded. It is a very serious obstacle to progress. A simple enabling act added to such building codes as are inflexible, empowering the department to approve new materials and new structural systems that have been tested and found to meet the required standards, would clear the way there.

It seems to this writer that the obligation to correct these conditions is on the building industry itself. No doubt it will find that building departments will welcome such a program. Building departments are in a position to assist in setting it up, but the financing must come from private sources. There should be no strings on this financing. It should be done through a trust fund properly administered. The bureau should be under the direction of a representative board of direction made up of building officials and representatives of industry. They should employ a competent director of high standing to have full charge of the operation of the Bureau and hold him responsible for results. Every precaution should be taken to avoid any suspicion of undue influence. The technicians and scientists who conduct the tests and make the reports should be entirely free from all outside interferences or influence.

WALTER H. WHEELER
Professional Engineer
Minneapolis, Minn.

A Voice for All Engineers

Sir: Your editorial "A Voice for all Engineers" (*ENR* March 8, vol. p. 307) again points out the urgent need for an overall organization through which all qualified engineers, both registered and non-registered, may exert one powerful voice on engineering matters of local, state and national interest.

For the past thirty years the American Association of Engineers has been working on a fourfold program; to promote the social and economic welfare of the engineer, to stimulate public service in the profession, to encourage and develop the efficiency of the engineer, and to promote unity in the profession. The foregoing association has the nucleus for building up such an organization as will be required during the postwar transition period.

During the past nine years the National Society of Professional Engineers has endeavored to enlist the aid of some twenty state engineering societies to have qualified engineers register under their respective state registration laws, and also to compel them to become members of the national society. They take the position that the only legal engineer is the one who is registered, but this premise is unsound because most of the states do not require many qualified engineers to register due to the character of their employment.

In view of this fact, it appears on the surface that now is the opportune time to amalgamate all of the professional-objective groups into one all-inclusive non-technical business organization that can speak with authority for the entire engineering profession.

WALTER O. HILL
Hannibal, Mo.

Moment Distribution

Sir: D. B. Steinman's article (*EN* Jan. 25, 1945, vol. p. 135) demonstrates once again the exceptional simplicity of structural analysis by mean of graphical or semi-graphical methods or by methods based on graphica or mechanical interpretation of elastic deformations (see writer's letter *ENR* Sept. 7, 1944, vol. p. 270). I this article is presented an elegant and labor-saving procedure of analyzin rigid frames having the advantage o geometric and elastic symmetry.

It may not be amiss to mention tha similar simplifying principles can b adapted for unsymmetrical bents an closed frames.

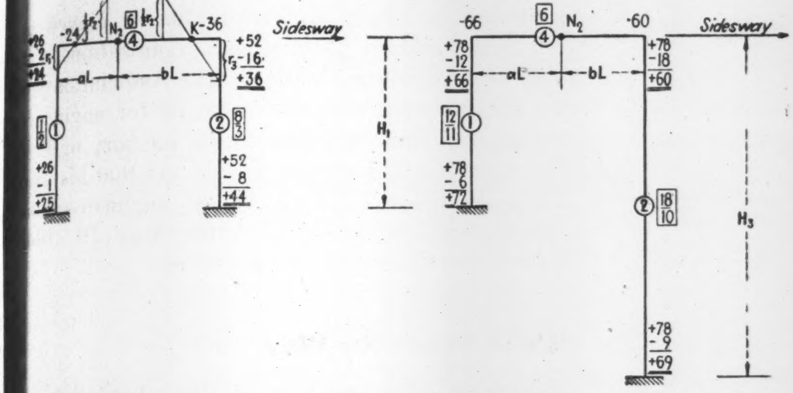
As an example, the application anti-symmetric loading to sideswa will be demonstrated.

In Fig. 1 the complete solution given by two direct moment distributions, using for the middle spa

$$r_2' = \frac{3}{2} \times 4 = 6$$

as effective rigidity.

Due to unsymmetrical columns, t node point N_2 is no longer at the mi



nsymmetrical bents can be analyzed by graphical moment distribution. Fig. 1, n the left, gives the solution for sidesway in a bent with equal legs and Fig. 2, n the right the solution for a bent with unequal legs.

oint of the span, but distant from the orners of the bent by $a = 2/5$ and $b = 3/5$ of the span, as can be seen in he previous articles by Mr. Steinman, ublished in *ENR*, or by determining he node point as the elastic centroid f an elastically restrained beam.

The ratio $a/b = \frac{2}{3}$ is the ratio of istances i and k between the conjuate points J and K and the adjacent nds of the beam.

$$\frac{a}{b} = \frac{i}{k}.$$

The node points N_1 and N_3 of the olumns in the case of symmetry are efined by relationships (see Fig. 6 of Ir. Steinman's article):

$$\frac{r_2}{r_2 + \frac{r_1}{3}}, \quad \frac{r_2}{r_2 + \frac{r_3}{3}}.$$

For all unsymmetrical cases, with qual or unequal legs, similar relaonships can be derived, viz.

$$\frac{r_2}{r_2 + c_1\frac{r_1}{3}}, \quad \frac{r_2}{r_2 + c_3\frac{r_3}{3}}.$$

Substituting the values of the nsymmetrical bent shown in Fig. 1, e have

$$c_1 = 3 - \frac{1}{a} = 3 - \frac{5}{2} = \frac{1}{2}.$$

$$c_3 = 3 - \frac{1}{b} = 3 - \frac{5}{3} = \frac{4}{3}.$$

A direct moment distribution can carried out by introducing the llowing effective rigidities:

$$r_1' = c_1 r_1 = \frac{1}{2} \times 1 = \frac{1}{2}.$$

$$r_2' = \frac{3}{2} r_2 = 6.$$

$$r_3' = c_3 r_3 = \frac{4}{3} \times 2 = \frac{8}{3}.$$

The solution of a similar bent with s of unequal length is practically ntical, only the distances a and b are to be calculated by taking into account the lengths H_1 and H_3 as follows (Fig. 2):

The values a and $b = 1 - a$ in the case of a bent with equal legs($H_1 = H_3$) resulted from the known relationship

$$\frac{i}{a-i} = \frac{k}{b-k}.$$

In the case of a bent with unequal legs the relationship reads

$$\frac{i}{a-i} = \frac{H_1}{H_3} \times \frac{k}{b-k}.$$

Assuming, for example, $H_1/H_3 = \frac{1}{2}$ (Fig. 2), we have $i = \frac{1}{9}$, $k = \frac{1}{8}$.

$$a = \frac{11}{21}, b = \frac{10}{21}, c_1 = \frac{12}{11}, c_3 = \frac{9}{10}.$$

With these values, two direct moment distributions yield the complete solution of the problem.

J. J. POLIVKA
Consulting Engineer
Berkeley, Calif.

Building vs bomber

Sir: While the force delivered against the side of the Empire State Building by the heavy army bomber traveling at something between 250 and 300 miles per hour, represents a tremendous potential for destruction, it will not come as a surprise to engineers that the structural damage actually sustained was so minor in nature, as indicated by newspaper reports. The ability of structural steel to absorb dynamic forces, measured as foot-pounds of work, is many times the assignment given it in normal structural design. Thus the forces suddenly applied by the crashing plane were largely absorbed locally, with the destruction of no more than a few spandrel beams, and, having been absorbed into the frame, they were transmitted to the foundations more or less elastically.

Considering the structure as a whole, designed for liberal wind loads and as a mooring mast for dirigibles, the forces involved in the accident lose some of their magnitude by comparison. However, it must be remembered that these forces were delivered almost at a point, rather than over the whole face of the structure. Hence extensive failures might have been expected by the layman.

That such was not the case is eloquent testimony to the inherent margin of strength which has led many observers of the effects of bombing in Europe to state that steel framed structures are more resistant to collapse than any other type.

The comparative ease with which the damaged members may be removed and new ones substituted will not be without significance to those familiar with construction.

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Concrete Without Forms

Sir: Apropos the remarks of Mr. A. J. Boase, in his article on "Brazilian Concrete Building Design" (*ENR*, June 28, 1945, vol. p. 902), concerning the expense of form work for circular stairways, as far back as 1920 helical concrete stairways were built in Rio de Janeiro without form work.

The method was based on the use of a steel pipe as a central support for the stairway. On this pipe were threaded as many preformed $\frac{1}{2}$-in. rods as there were risers. These rods were bent so that they would serve as reinforcing at the top and bottom of each riser and also to provide vertical reinforcing for the balustrade.

After the central support had been erected with the bent rods threaded thereon, the latter were swung around into their proper locations and held, provisionally, by pieces of notched wooden lath. Then, $\frac{1}{4}$-in. rods were run, helically, at the top of the vertical balustrade supports and the upper and lower outer corners of the risers.

The steel skeleton so formed was

(*Continued on page* 128)

EDITORIALS

VOLUME 135 NUMBER 6

August 9, 1945

Risks to High Buildings

CLEAR EVIDENCE of the potential ability of a steel-framed skyscraper to withstand unusual punishment is given in the spectacular collision of a bomber with the Empire State Building in New York on July 28. Weighing about 10 tons and travelling at a speed estimated at 250 mph., the plane struck the building squarely at a vertical column, hurtling its engines and flaming gasoline into the building. No permanent damage to the structure from the impact and fire is apparent. Those parts of the frame that were injured or destroyed were only of local importance and can easily be repaired or replaced. Thus support is given to the conclusion reached earlier in the war that bombing of our tall buildings would probably cause less rather than more destruction than was being caused in Europe where most buildings depend largely on their exterior walls for stability. That this accident will have any effect on the height of future buildings seems improbable, except possibly elimination of self-aggrandizing towers that have no economic justification. Experience appears to indicate that space on very high floors does not rent too well. Economic considerations, therefore, rather than possible accidents, doubtless will fix the height of future buildings.

Paul L. Brockway — An Appreciation

ONE COULD NOT ASSOCIATE LONG with Paul L. Brockway, who died on July 20, without becoming keenly aware of the many virtues that made him not only an outstanding engineer but a conscientious public servant as well. Throughout his 38 years in the public works department of Wichita, Kansas, his work was marked by soundly conceived engineering practice coupled with sympathetic application of those qualities that form the basis for harmonious public relations. To say that Paul Brockway inspired those associated with him is an understatement; his generous spirit was typified in the frequent admonition to the employees in his department that they always feel that they were working with him and not for him. His activities were not restricted to Wichita for he played an important role in professional organizations, notably the American Public Works Association and the Kansas state registration board for engineers. Perhaps no greater tribute to the memory of Paul Brockway could be given than to say that his written philosophy of the role of the engineer-administrator—which appeared in the May 19, 1945 issue—was the doctrine he practiced.

Waco Shows the Way

THERE IS NOTHING NAMBY-PAMBY about the way matters are handled in Texas. For example, consider the manner in which the Waco city commission plans to enforce the collection of sewer taxes (see p. 89 this issue). The ordinance drafted by the town fathers provides that those who are remiss in meeting their obligations will have service terminated by filling the sewer connection with concrete! Many a harassed public works administrator will read this and wish that he, too, could operate under an ordinance that had the same quality of simplicity and finality. While other communities live with the timid hope that a 7 percent penalty clause will bring in delinquent taxpayers, Waco can rest secure that a couple of buckets of concrete poised in the proper place will bring quick action.

Airport Access

IN ONE OF THE FIRST major attempts at elimination of the usual slow and costly transportation to airports, Boston will construct an extension to its rapid-transit system that will provide 10-minute, 10-cent, passage from the downtown area to the edge of the flying field. Boston's action may well serve as an incentive to other cities to improve the access and eliminate the cause for the often heard statement "It takes longer to get to and from the airports than to fly between the cities." If airlines are to make the best postwar appeal, it will be necessary to eliminate the unjustifiably high-priced limousine service that now is the chief means of access to most airports. Low-cost high-speed transit from centers of large cities to their airports would appear to be essential for the mass movement of the many thousands of people who are expected to go to metropolitan airports to travel, to work or for sightseeing. Because of the high cost, Boston does not now plan to carry its high-speed line to the transfer point within the airport, making bus transfer necessary. Although this compromise may be justified while the amount of traffic still is uncer tain, large cities cannot long afford to be without a direct connection if air travel after the war reaches the volume now anticipated.

Coral as Aggregate

REGARDLESS of what country retains control of the Pacific Islands after the war, all will benefit from the experience of American engineers on the islands they have captured. The use of coral as an aggregate for concrete is an example. Before the war it was not considered a suitable aggregate. But our boys had to build with it, and frequently they had to resort to the use of seawater to mix their concrete. They know now that reasonably strong and durable concrete can be made if the right type of coral is picked and if the proportioning is carefully controlled. Commodore Perry's article in this issue on coral as an aggregate adds valuable information to that given last year by Harold T. Stearns, geologist, in connection with the use of coral for airstrips (*ENR* July 13, 1944, vol. p. 31). Even the use of seawater to mix concrete has been found to have no serious effect. Thus again the old adage holds—necessity is the mother of invention.

Engineers' Authority Over Contracts

"FOR A COURT to substitute its own lay opinions, however well it may think itself informed through evidence, for the opinions of the engineers in the field to whom the parties have entrusted such decisions would be directly contrary to the terms of the contract and in the long run likely to produce unsound results."

Such was a dictum of the Massachusetts Supreme Judicial Court in a case in which the right of engineers to control contract work was upheld unequivocally. Indicative of the tenor of the court's opinion, reported elsewhere in this issue, is the following: "The embankment was not to be built to conform to the borrow pits. On the contrary, all borrow pits used must conform to the requirements of the embankment."

The court went on to say that "neither reasonableness in the ordinary sense nor necessity determine the limits of the engineer's power." This latter appears questionable and harsh on first examination, and yet it is sound logic. So long as a court can find no evidence that the engineer's decision was "arbitrary, capricious or tainted with fraud" it should not substitute its opinion for that of the engineer.

In so saying, the court has added a significant statement to the jurisprudence relating to engineering contracts. At the same time it has reemphasized the engineer's responsibilities. Possessing such broad powers the engineer, in his decisions, must not compel the contractor to go beyond the clear intent of the contract.

Construction and the British Elections

THE BRITISH PEOPLE voted for the fruits of construction when they so unceremoniously pushed their great war leader, Winston Churchill, out of the prime minister's post recently. More erudite and cosmic explanations, involving socialism, communism, war weariness, colonial reform, monopolism, etc., will be made, but they merely screen the basic reason, a human desire for better living, and most importantly in this instance, housing.

A program to provide that in sufficient volume, the people reasoned, will also provide the other basic need and desire—jobs. Mr. Churchill and his Conservative Party had, of course, promised these postwar rewards, but the people doubted either their sincerity or ability and bet on the more vigorous, even though untested, Labor Party. The future will determine whether their judgment was good or bad.

In the meantime, one can recall that it was under Churchill's coalition government that the Barlow, Scott and Uthwatt reports on industrial population shifts and land utilization were authorized and made; that the Ministry of Town and Country Planning was formed; and that the policies of this ministry began to skirt the edges of the land-nationalization idea, and to plan housing reform upon a grand scale. Britain has been looking beyond the battle for a number of years (*ENR* June 15, 1944, vol. p. 890).

And even with more militant elements in power, it is probable that the historic British tendency toward compromise will cause coalition rather than radical ideas to prevail. In any event, the construction industry and its engineers and contractors have been chosen for a major role in determining Great Britain's future. Wishes are world-wide for their success in the construction task they are about to undertake.

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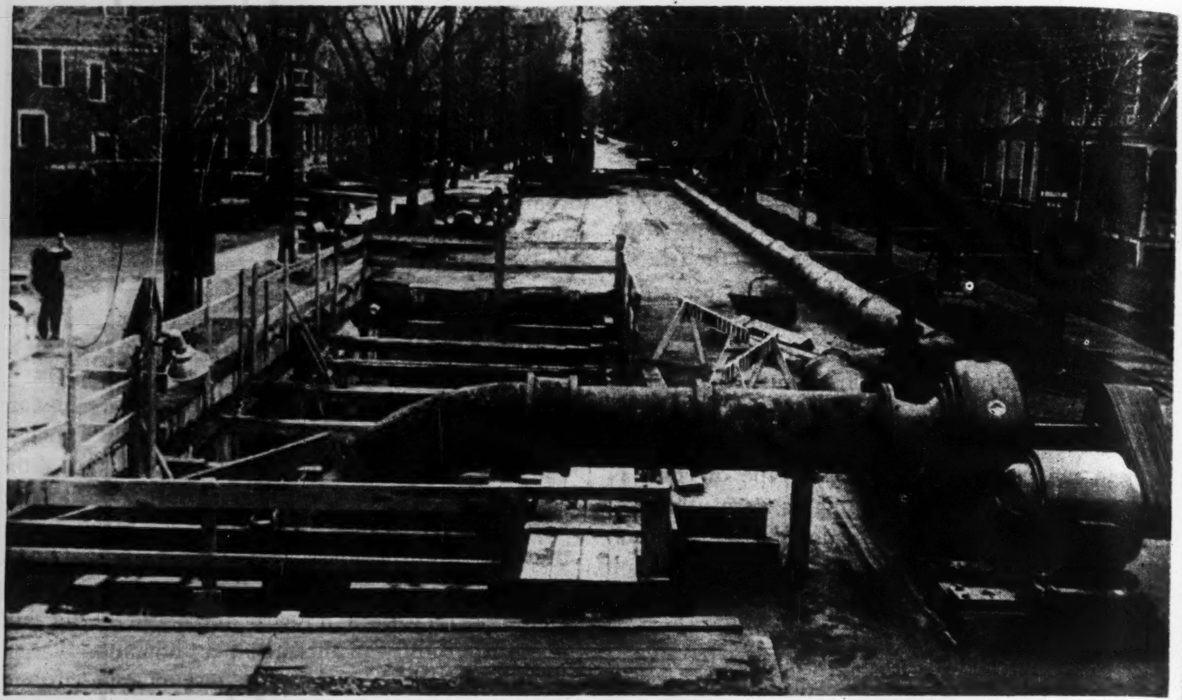

Fig. 1. Collapsed section of Syracuse trunk sewer was bypassed by 24-in. booster pump in 20-in. cast iron siphon line.

A Sewer Repair Race Against Time

Contents in Brief — *When a large, brick, trunk-sewer of egg-shaped section in Syracuse, N. Y., collapsed, difficulties to be overcome included handling an anticipated 10 to 50 mgd. of sewage and runoff from melting snow, and securing sufficient labor to complete repairs before expected heavy spring rains set in. The flow was bypassed through a 20-in. siphon 350 ft. long, with a 24-in. low-head centrifugal pump borrowed from the Netherlands Government as a booster in the line. German prisoners-of-war were utilized as common labor for the repair work.*

WITH EXCEPTIONALLY DEEP SNOW accumulated in the tributary area, and with heavy warm spring rains expected daily, repair of a collapsed section of main trunk-sewer in Syracuse, N. Y., became a race against time. Not only was there the fact that some 1,100 cellars would be flooded if high flows overtaxed emergency outlets, but there was also the possibility that more of the sewer would weaken and collapse. Equipment and labor shortages were not the least of the problems involved.

This combination of circumstances called for extraordinary measures to facilitate the repairs. To construct a bypass siphon, 20-in. cast iron pipe was borrowed from the city's water division. Also borrowed was a 24-in. low-head centrifugal pump, manufactured here for the Netherlands Government and intended for unwatering flooded areas in that country. The pump was used as a booster in the siphon line.

Even labor was "borrowed." Skilled workers were transferred from the water division, but common laborers were unavailable. Arrangements were made with Army authorities, therefore, to use 30 German prisoners-of-war, already employed by the city on a snow removal campaign, for the sewer repairs.

The collapsed sewer was a section of the Midland Avenue trunk (see Fig. 2) between Borden and McLennan avenues. Completed in 1899, the egg-shaped brick sewer is 87 in. high and 58 in. wide, with the invert about 23 ft. below the paved street surface. It carries all of the sanitary flow and a large amount of the storm drainage from the southeastern sections of the city. During hard rains, and particularly in spring when warm rains rapidly melt accumulated snows, flow varies from 10 to 50 mgd.

Inspections showed cracks

Inspections of this sewer have been made at various times during the past 14 yr. to determine any changes in its condition, especially where the arched roof showed signs of settlement. In 1935, at a point about 50 ft north of the manhole at Borden Ave., the following condition was reported: "$\frac{1}{2}$-in. crack in roof, gravel in bottom," (Fig. 3).

Through cracks like this (and there are many others throughout the length of the sewer) the sand in which the conduit is built is washed by surface drainage seeping from above. As this washing continues over a period of time, large voids are created under such substructures as water and gas mains. When sufficient supporting material is washed away, these mains settle and break. It so happens that a 6-in. cast iron fire-hydrant connection crosses the Midland Ave. sewer at the point previously mentioned.

On February 15th, 1945, this hydrant connection broke. After the water was shut off, a section of the pavement collapsed and a cavity extended under the remaining pavement for about 50 ft. in length, 10 ft. deep and nearly the full width of the pavement (Fig. 4). None of the material washed out of the hole was in evidence.

Suspicion of break confirmed

Removal of the manhole cover at Borden Ave., just upgrade from the break, revealed that the sewer was backing up. At McLennan Ave., one block down grade, the sewer had considerable sand and gravel in it with a very small flow going through. This confirmed the suspicion that a section of the roof of the sewer had fallen and that the material from the hole under the pavement had washed into the sewer.

The commissioner of public works, who has charge of the maintenance and repair of sewers, called in a contractor to make the necessary repairs. The following day work was started to break out the undermined pavement and sheet a trench 32 ft. long by 11 ft. wide, beginning at a point about 35 ft. north of the manhole at Borden Ave. Work was also started on diversion of the sewer flow.

The first step toward diverting the flow was to block the Colvin St. and Brighton Ave. trunk-sewers where they connected with the Midland sewer, forcing them to discharge into nearby Onondaga Creek. Also, several pumps of 8-, 6- and 4-in. size were set up at the Borden Ave. manhole, discharging to a nearby manhole in an old 24-in. concrete-pipe sewer on the east side of Midland Ave. and flowing north to Kennedy St.

Park area acts as reservoir

About this time water began to rise in a large sunken garden located in Kirk Park, which lies about 300 ft. west of, and considerably lower than, Midland Ave. This was caused by the water rising in the manhole at Borden Ave. to a point where it backed up through a 3 ft. by 6 ft. concrete culvert built years ago to carry the flow of Onondaga Creek while a channel improvement was carried out. This culvert extends some distance across Kirk Park, and has several surface drains connected to it.

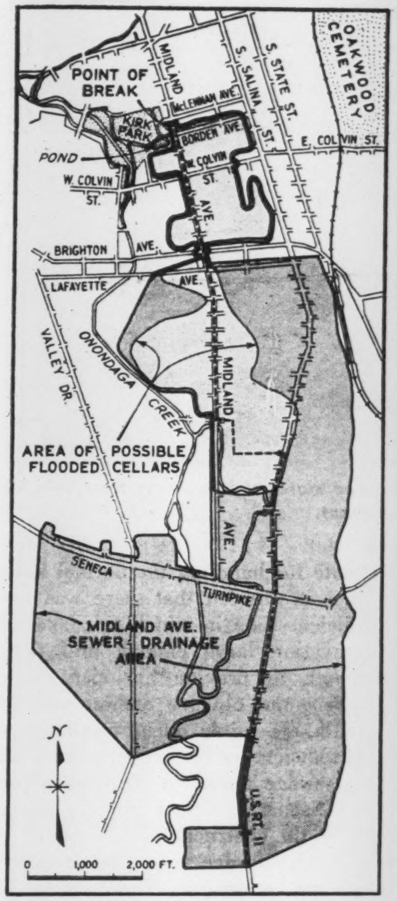

Fig. 2. Midland Ave. trunk sewer drains a large area of southeastern Syracuse. Inner area is that in which cellar flooding would occur if storm flow overloaded bypass.

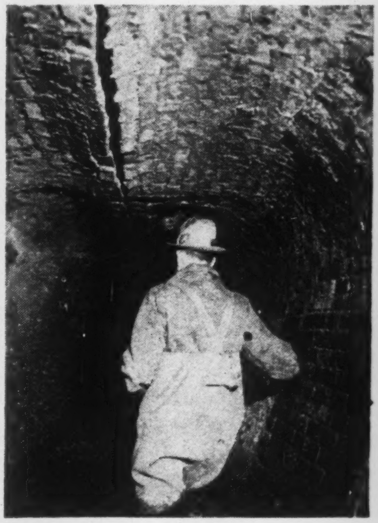

Fig. 3. Picture taken during 1935 inspection shows arch settlement in egg-shaped Midland Ave. sewer. This section was built in 1899.

One of these drains, located in the sunken garden, allowed the backwater from the sewer to run out. Levels showed the water surface both in the manhole and in the garden to be the same. At its highest, the sewage rose to between 11 and 12 ft. below the rim of the manhole, at which time it was from 3 to 4 ft. deep in the garden. The sunken garden, about 150 ft. by 350 ft. in size, acted as a reservoir for the sewer flow in excess of the capacity of the pumps.

The contractor continued excavating and sheeting the opening over the break until the roof of the sewer was exposed. Excavated material was stored nearby on the Borden Ave. roadway leading into Kirk Park. As was expected, a hole was found in the top of the sewer. This hole was about 15 ft. long and in it, surrounded by sand, gravel and brick, two large slabs of concrete pavement stood on edge, side by side. Each slab was about 12 ft. long, 7 ft. wide and 1 ft. thick. The sewer was plugged to within a foot of the top.

Realizing the seriousness of the situation and the size of the task involved, the commissioner at this point requested the city engineer to take over the work. This was at noon on February 26.

War prisoners used as laborers

Two complete shifts of 12 hr. each were immediately organized to speed up the repairs. All the contractor's equipment on the job, including pumps power cranes and compressors, was placed on a rental basis and all his operators and workmen were placed on the city payrolls.

To carry out the double shift operations additional foremen, sheeters and skilled laborers were transferred from the water division; common laborers, however, were unavailable so the transfer of 30 German prisoners-of-war was made. These prisoners were divided into three groups, each group working 8 hr. per day.

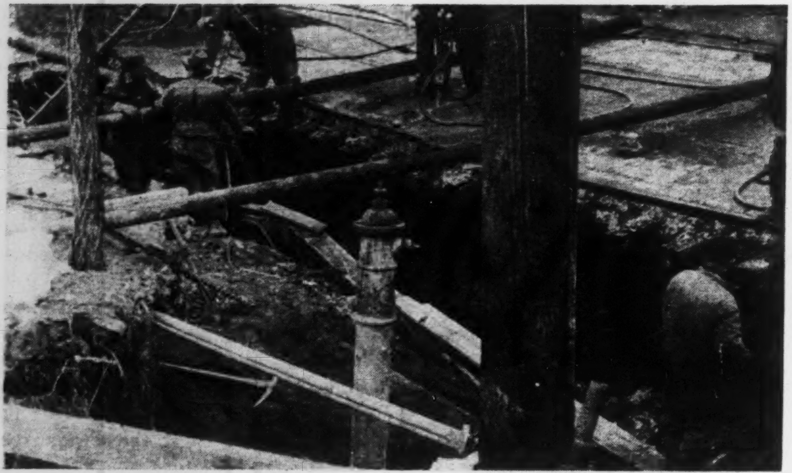

Fig. 4. Broken 6-in. hydrant connection washed material into sewer from hole 50 ft. long, 10 ft. deep, and full width of pavement.

They were used for excavating, carrying timber, unloading materials and all other laborious work, thereby solving the labor shortage problem very satisfactorily.

In order to carry on the work 24 hr. a day, a system of floodlights was set up whereby not only the entire site on the surface, but all trenches and shafts being excavated were properly illuminated to increase efficiency and eliminate danger of accidents.

Larger pumps needed

Pumping equipment in operation at the time the city engineering department took over was considered inadequate for handling the normal flow. Since it was felt that there was not sufficient time in which to make an excavation large enough and deep enough to provide an open flume bypass, the obvious answer was to obtain, if possible, one or more pumps of sufficient capacity to remove all the sewage ahead of the obstruction and discharge it back into the sewer below the obstruction.

As the sewage flow was estimated to vary in quantity from 20 to 30 cfs. (about 13 to 19.5 mgd.), a 20-in. pump and preferably one of 24-in. size was required. Moreover, the pump must necessarily be of such design that it could pass some solids without clogging and without the use of anything but a relatively coarse screen. Experience with the smaller pumps had clearly demonstrated the impracticability of conventional strainers on suction hoses and pipes.

Pumps of this size and type are not readily available, especially in wartime. Contacts were made with all known users of large pumps of this type, including local contractors, the State of New York, industrial concerns and used-equipment dealers. It was impossible to find anything of sufficient size which could be powered in a matter of a few days. Inquiries to several pump manufacturers were also to no avail.

Pump and motor loaned in crisis

Finally, it was learned from the local representative of the Worthington Pump & Machinery Corp. that his company had in stock a 24-in low-lift pump designed to handle water containing solids and equipped with a V-belt pulley. Designed for diesel engine drive, the pump was one of several constructed for delivery to the Netherlands Government for use in un-watering large areas flooded by the Germans during war operations.

It was learned that the pump company would lend this pump for two or three weeks, if arrangements could be made with the Netherlands Purchasing Commission for its release. Several telephone calls to New York City resulted in the necessary release.

For several reasons, including dependability, quietness, simplicity of operation and the fact that power was available on Midland Avenue, it was decided to use electric drive. It was necessary, however, for the power company to run a third wire from Colvin St. along Midland to Borden Ave. (the site of the pumping installation), and to erect an extra pole for a transformer installation.

While arrangements for the pump were being made, a similar search was being made for a 100-hp. electric motor of suitable characteristics. Here again, many telephone calls were made, with the result that the General Crushed Stone Co., with offices in Syracuse, offered the loan of a motor of the right type. This motor had just been purchased for installation at the company's Auburn plant.

All of these arrangements having

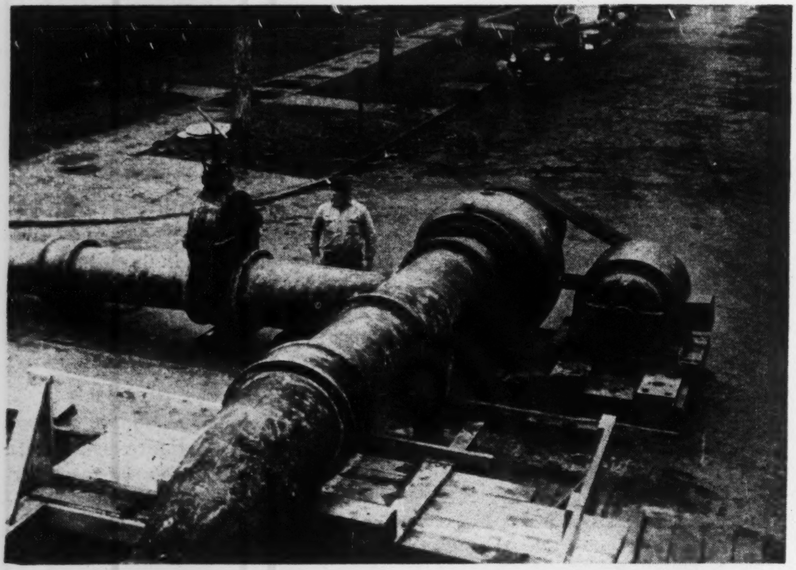

Fig. 5. Centrifugal 24-in. pump was installed as booster in 20-in. siphon line. This view shows 20-in. cast iron pipe caulked directly to flange of 24-in. throttling valve on discharge side of pump.

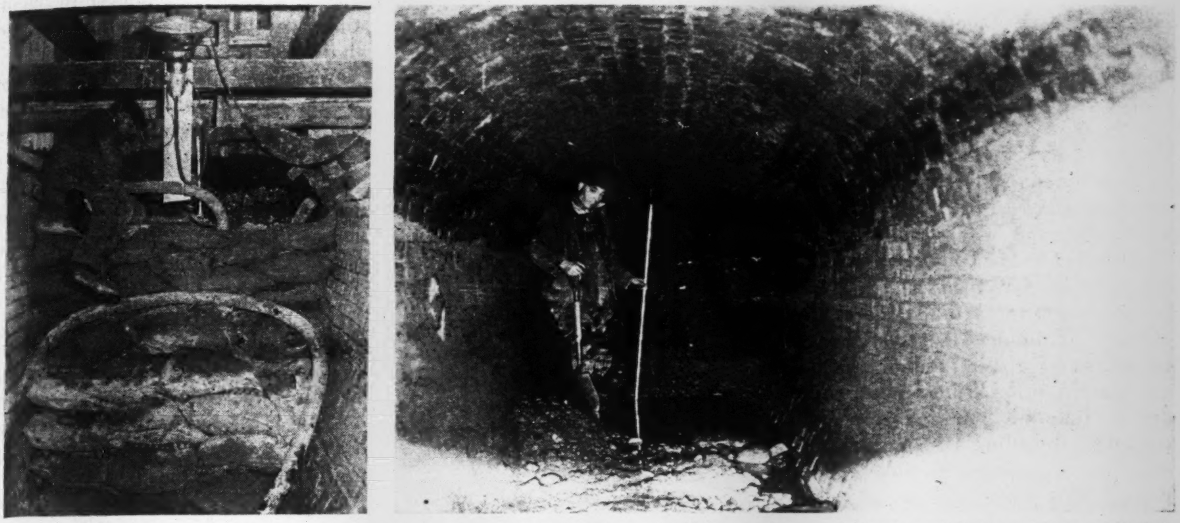

Fig. 6. Left: For 50 ft. upstream from break sewer was filled to within 1 ft. of top. Note how brick arch has settled to heart shape. Right: Sand and gravel in sewer sloped down to 4-ft. depth 300 ft. downstream from collapsed section.

been completed within 24 hr. of taking over the job, trucks were dispatched simultaneously to Harrison, N. J., for the pump, to Rochester, N. Y. for the motor and motor starter, and to Buffalo, N. Y., for motor pulley and V belts. About this time arrangements were also completed with the electric company for the power installation.

Sufficient head for siphon

Preliminary studies of the problem had indicated that a siphon of large size might be successful in bypassing the sewage around the obstruction. This involved laying some 350 ft. of air-tight pipeline and providing a practical means of priming this large siphon in a reasonable length of time. The only pipe readily available was some 20-in. cast iron water pipe belonging to the water division.

Calculations indicated that with the sewer just full at Borden Ave. a differential head of 4 to 5 ft. could be obtained for operating a siphon from a manhole at Borden Ave. to a manhole at McLennan Ave. The capacity of such a siphon was estimated to be about 10 or 11 mgd. providing it could be successfully primed. As the capacity of the pump under the same conditions of head was estimated to be about 11 mgd.; it was decided to provide both means of unwatering the sewer as alternate methods in case of failure of either, and to operate them simultaneously in the event of high flows.

Personnel of the water division began to lay a line of 20-in. pipe on Feb. 27th. By the next day it had been completed from McLennan to Borden Ave. Joints were run with lead and caulked to insure an airtight line.

Pump installed as siphon booster

On the morning of March 3 the siphon was ready to be completed by installing the intake in the manhole at Borden Ave. Thawing weather, together with rain, had raised the level of the sewage during the night so that the sewer was completely filled. Under this condition there appeared to be considerable hazard in removing a portion of the sewer arch upstream from the Borden Ave. manhole, an operation necessary to installing a siphon as well as a pump suction. It was decided, therefore, to use the pump as a booster in the siphon line (Fig. 5), since computations showed that the capacity of such a combination would equal the combined capacities of the separate installations.

Work on this scheme was immedi-

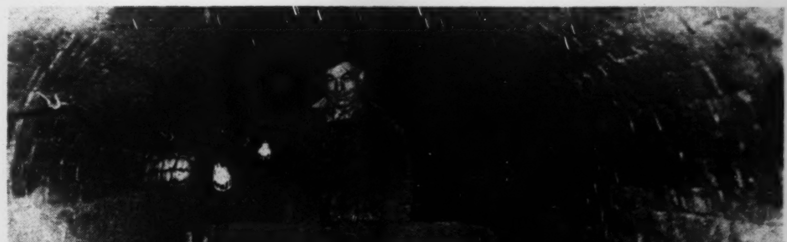

Fig. 7. Debris was removed from sewer by filling ½-yd. bucket on narrow-gage car. Crane lifted bucket through opened section for dumping. Bed for track is 2 ft. of gravel left in invert and cleaned out later as track was removed.

ately undertaken, and at 10:30 P.M. on March 4 the pump was operated for the first time. The following day it was put into regular service and operated almost continuously until March 19, by which time repairs to the sewer itself had been completed.

To avoid possible clogging of the pump impeller by rags or pieces of wood, a screen with 3-in. openings was constructed of two layers of paving mesh reinforcement with a plank frame shaped to fit the sewer at the manhole. Priming was accomplished by means of a 3-in. siphon ejector, operated by water from a nearby hydrant. Rate of pumping was controlled by throttling a 24-in. valve located on the discharge side of the pump. This valve was closed when priming the pump.

Full pump capacity not needed

While the rate of pumping varied throughout the 24 hours, a typical condition under which the pump operated was a total lift of 22 ft. with zero pressure at the pump discharge connection. When the valve in the discharge line was throttled under this condition a 19-ft. negative head was caused on the downstream side by the siphon action in the pipe. Rate of pumping under these conditions was about 7.75 mgd. as determined by characteristic curves of the pump.

During the entire operation of the pump, sewage flow was at no time sufficient to require that the throttling valve be more than one-third open.

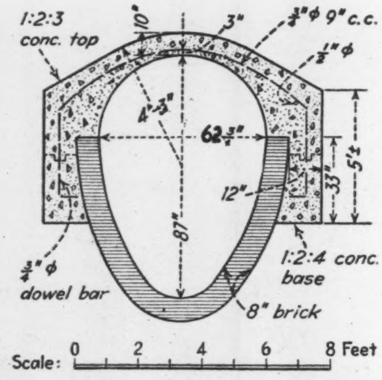

Fig. 8. Section showing how collapsed brick roof of egg-shaped sewer was replaced with reinforced concrete arch resting on new bases.

Completion of the bypass arrangements opened the way for cleaning the plugged sewer. Until this was done, no one could estimate the damage or the conditions that would be found. And on this depended the decision whether to repair the old sewer or replace the damaged section with new pipe.

In either case, the trench as excavated was too narrow, so steps were immediately taken to widen it to 19 ft. This involved excavating spaces about 4 ft. wide outside of the existing sheeting and maintaining the old braces and sheeting while new were being placed. The excavation was made by the prisoners-of-war, who loaded a clam-shell bucket by hand, since working space was so restricted that the bucket could not dig.

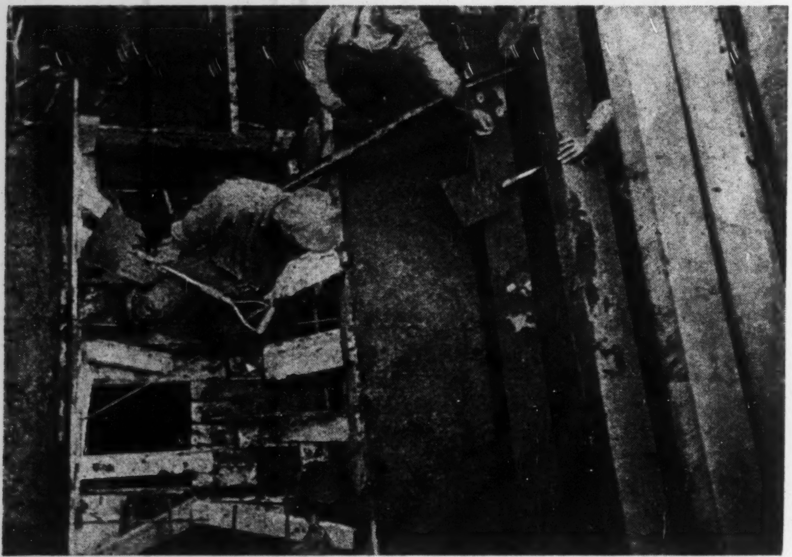

Fig. 9. Entire 65 ft. length of new crown was placed in continuous pour except for this 4-ft. section left open for form removal. This space was later concreted using forms hung from trench bracing.

Widening of the trench brought within the limits of the excavation an 8-in. high-pressure gas main and a telephone subway containing six cables, some of which carried toll lines. It was necessary to relocate the gas main, and support the telephone cables from the trench braces.

Narrow-gage track used in sewer

After the new sheeting had been driven its full length, the existing sheeting was removed and a second, or lower lift, was driven to a point halfway down on the sewer. As soon as this was done, the clam-shell bucket was used to remove the debris from the sewer at the point of the break.

Inspection at this time showed that the sewer was filled with debris to a point about 1 ft. below the roof (Fig. 6, left), extending from the break upstream to the manhole at Borden Ave. From the break downstream to the manhole at McLennan Ave., the material in the sewer gradually sloped down to a depth of about 4 ft. (Fig. 6, right). Approximately 250 cu. yd. of material had to be removed from this section of the sewer.

As removing this quantity of material by wheelbarrow would require considerable time, a narrow-gage track (Fig. 7) was laid so that a ½-cu. yd. dump bucket on a car could be pushed back to the opened section, where a power crane hoisted it out and dumped the material into trucks to be hauled away. About 2 ft. of gravel was left in the bottom of the sewer as a base for the track, to be removed later as the track was taken out.

An auxiliary shaft 15 ft. square was excavated and sheeted about 50 ft. south of McLennan Ave. This provided an additional outlet for removing material from the sewer, a place for pumping, and, as a safety measure, would serve as an alternate exit for men working in the sewer. As the work of cleaning progressed electric lights were strung along the inside of the sewer and fastened by means of screw-eyes in the brickwork.

Repair method selected

As soon as the cleaning operation was finished, the sewer was examined to decide whether to lay new pipe or repair the old sewer. The brickwork in the lower half of the sewer, below the arched roof section, seemed to be in fair condition even though water came through joints in several places, some as much as $1\frac{1}{2}$ ft. above the invert. This indicated that the groundwater level was at least that high.

To lay new pipe would require installation of large-size pumping equipment in order to cope with this quantity of groundwater. In addition, the season of the year was approaching when rain storms of such intensity as to overtax the capacity of the by-pass pump might occur. In that case the overload would flow into the trench with possible serious results.

After thoroughly studying the conditions and possibilities, it was decided to cast a reinforced concrete arch over the remaining section of the brick sewer. In addition to the 32-ft. section originally uncovered, the remaining 33 ft. extending to the Borden Ave. manhole was opened up as it was found that the roof had settled to a heart-shape form with a large crack running through the center. (See Fig. 6, left).

How roof arch was built

In making the repairs, the brickwork was removed along the entire length of the section to be repaired, to a point just about at the spring line of the arch. This was no difficult task because individual brick could readily be picked off by hand, there being no bond between the mortar and brick.

Trenches were then dug adjacent to the outside of the sewer, 12 in. wide and from 24 to 33 in. below the top of the brickwork left in place (Fig. 8). These trenches were filled with a 1:2:4 mix concrete to act as a base for the new arched roof. Keyways were left in the tops of these bases and $\frac{3}{4}$-in. dowel bars were set on 9-in. centers. These bars were 4 ft. long and projected 2 ft. out of the base to lap the arch reinforcement.

While the base was setting up, semi-circular forms conforming to the inside roof section of the sewer were fabricated from 2-in. lumber. These forms were supported by 2x6s forming a V and resting on 4x8s placed along the invert. Wedges driven between the bottom timbers and the supporting legs adjusted the height of the forms. These supports, spaced on 3-ft. centers, were held in place by longitudinal braces. On top of the semi-circular forms 2x4s were laid side by side and covered with tar paper. Side forms were carried straight up from the outside of the bases to about 1 ft. above the top of the brick side walls.

Reinforcement for the arch consisted of curved $\frac{3}{4}$-in. bars on 9-in. centers and lapping the dowels poured in the base, and longitudinal $\frac{1}{2}$-in. bars spaced 18 in. on centers.

Ready-mix concrete used

The entire roof section was put in as a continuous pour, with the exception of a 4-ft. section (Fig. 9) left as an opening for removing the forms and later closed by hanging the forms from wires attached to the trench braces. Ready-mix concrete of 1:2:3 proportions was used, but water was not added until after arrival on the job. Thus the concrete was kept stiff enough so that it could be sloped to conform to the upper contour of the arch. Job-cured test cylinders showed 5-day compressive strength of 2,900 psi.

Three days after the main roof section was poured, the forms were removed. After the forms were out, the screen and dam in the Borden Ave. manhole were removed, the 24-in. pump was shut off, and the flow allowed through the sewers.

Since the manholes at Borden Ave. and McLennan Ave. had been torn down to provide space for pumping operations, they had to be rebuilt. It was also considered advisable to construct a new manhole in the auxiliary shaft just south of McLennan Ave. in case of further breaks in this vicinity. These manholes were constructed 8 ft. square to provide ample space for any future pumping equipment without the necessity of excavating a shaft to the sewer.

Following the pouring of the concrete roof over the sewer and the start of manhole construction, there was no further need of a large number of laborers. On March 21, therefore, the war prisoners were returned.

When the manholes had been carried up a sufficient height, backfilling of the trench was started. The material previously stored on the Kirk Park entrance roadway was used for this, the engineering department's power shovel loading it into trucks to be hauled and dumped directly into the trench.

Those in charge

P. W. Kelly, deputy city engineer, was in general charge of the project, reporting to N. F. Pitts, city engineer. E. P. Stewart is division engineer for water, and H. T. Kieffer is division engineer for sewers.

Aluminum Alloy Bridge Floor Reported to Perform Satisfactorily

During the fall of 1933, aluminum alloy members were used to replace the inadequate floor system of two 360-ft. truss spans of the Smithfield St. Bridge in Pittsburgh, Pa., saving in dead load more than one ton per lin. ft. of bridge (*ENR* Nov. 23, 1933, p. 611, and Dec. 28, 1933, p. 783). Since then, the bridge has been open to all traffic, including streetcars.

In a report dated June 15, 1945, on the condition of the aluminum alloy floor system after 12 yr. of service, C. C. Sadler, Highway Bridge Engineer, Public Roads Administration, concludes, "That the highway part of the Smithfield St. Bridge has functioned for 12 yr. in the manner originally planned and that the streetcar section has functioned equally well after initial modification of design faults leads to the conclusion that the experiment was successful and that it has opened a new field for aluminum alloy metal and has aided in the solution of a difficult design problem of bridge engineering."

On the basis of the service history of this floor system, Mr. Sadler also comments that, in general, aluminum alloy structural shapes can be used effectively whenever dead load reduction is necessary. He believes that this metal can be used in new structures having movable, opening, and long spans and in remodeling and prolonging the life of old bridges, as was done in this case.

Design of Rectangular Steel Tanks

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Contents in Brief *— Although the exact design of a rectangular, steel plate tank is very complicated, in practice certain simplifying assumptions are made. Based on these assumptions, charts for obtaining thickness of plate, spacing of stiffeners, and loads offer a time-saving design method. As an illustration, charts for a horizontally-stiffened tank are discussed.*

FORMING AN IMPORTANT PART of industrial equipment, tanks are built of practically every kind of material used in construction and in almost endless variety. A type which has widespread application is the rectangular tank fabricated from steel plates.

The sides of such tanks usually require structural reinforcement. This may be provided in several ways, one of which is to run rows of stiffeners horizontally around the tank, usually on the outside so that the interior is free from obstructions. The design of such tanks includes an investigation of the stresses in the plate and of the loads carried by the stiffeners. An exact determination of these quantities is difficult, as the problem is complicated by plate continuity and by the deflection of both plate and stiffeners under load.

It has been found satisfactory in practice to assume that the plate panels between stiffeners act as simple beams. Based upon this assumption, the accompanying charts make it possible to obtain without computation the maximum moment in the plate and the distribution of the loads to the stiffeners for desired combination of plate thickness and stiffener spacing.

The loading assumed is that due to the pressure of water weighing 62.4 lb. per cu. ft. Moments and reactions produced by any other material are in proportion to equivalent fluid pressures. Based on this hydrostatic pressure, moment curves are plotted on Fig. 1 to include tank depths up to 12 ft. Also, on this chart resisting moments at 18,000-psi. stress for various plate thicknesses are indicated by horizontal lines. The corresponding upper reactions for hydrostatic pressure are plotted on Fig. 2 and the lower reactions on Fig. 3.

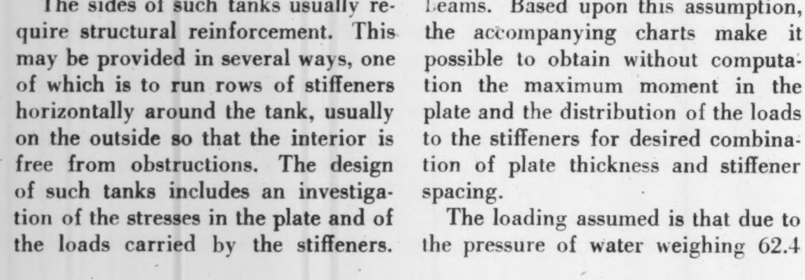

Fig. 1. Curves indicating the relation between bending moments due to water pressure and distance from the top of a tank are used to determine plate thickness and location of stiffeners. Design of 6-ft. deep tank, illustrated by dotted line, calls for $\frac{1}{4}$-in. plate and a stiffener 3.6 ft. from top.

Charts used to design tanks

To illustrate the use of the charts, consider a tank open at the top and 6 ft. in depth. The first step is to decide upon the plate thickness. As will be explained later, Fig. 1 shows that for $\frac{3}{16}$-in. plate a stiffener around the top and two additional rows intermediate between top and bottom will be required. One intermediate row will be necessary for $\frac{1}{4}$ in. and all gages to and including $\frac{7}{16}$ in. One-half inch plate will carry the load with only a top stiffener, although the deflection might be objectionable. Of these gages $\frac{1}{4}$ in. will be selected as the lightest that can be used with two rows. The manner in which this information is obtained will be made clear by the following procedure.

Since the tank is open, a stiffener beam will be placed at the top. To locate the next stiffener, enter Fig. 1 at depth = 0 and moment = 0 and follow along the first curve to where it crosses the $\frac{1}{4}$-in. plate line at 3.6, the depth in feet below the top at or close to which the beam should be placed. Another stiffener location is indicated where a curve starting at depth = 3.6 and moment = 0 would cross the $\frac{1}{4}$-in. plate line. Here, since depth = 5.9, practically at the tank bottom, the bottom plate will provide the support.

To find the loads start in Fig. 2 at depth = 6 and load = 0 and follow the curve to the left until it crosses

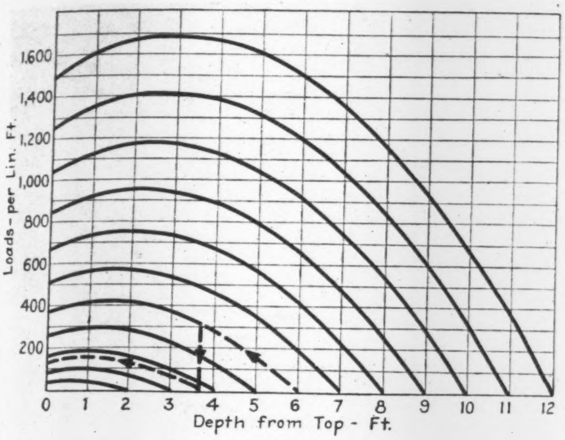

Fig. 2. The load per linear foot transmitted to a horizontal stiffener by the panel below it is obtained from this chart. By following the dotted line, the loads can be found for a 6-ft. deep tank with a stiffener placed 3.6 ft. from the top.

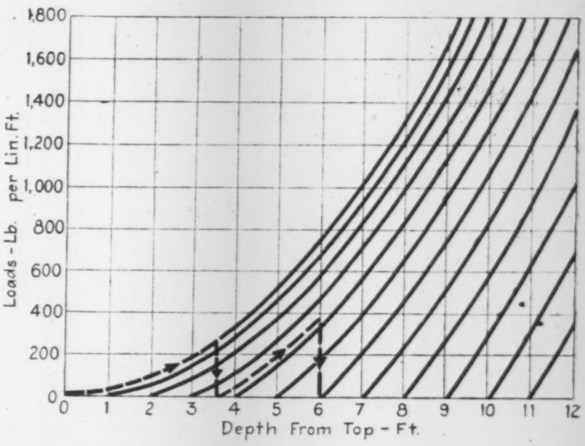

Fig. 3. The load per linear foot transmitted to a horizontal stiffener by the panel above it is indicated by these curves. Again, the dotted lines show how to find the loads for a 6-ft. deep tank with a stiffener placed 3.6 ft. from the top.

the vertical at depth = 3.6, where load = 330 lb. per lin.ft. This is the load that the stiffener at 3.6 receives from the lower panel. The load transmitted to the top stiffener by the upper panel is found at the intersection of the curve that starts at depth = 3.6 and load = 0, and the ordinate depth = 0. Here, the load is 140 lb. per lin. ft., which is the total for this member.

To obtain the load which the beam at 3.6 receives from the upper panel, enter Fig. 3 at depth = 0 and load = 0 and follow the curve to depth = 3.6, where load = 270 lb. per lin. ft. This added to 330 lb. per lin. ft. from the lower panel gives a total of 600 lb. per lin. ft. for that member. The load at the bottom is found on the 6-ft. ordinate, 0.6 of the distance from curve 3 to curve 4, and equals 380 lb. per lin. ft.

The total load on the side equals the sum of the loads on the supporting members, or 1,120 lb. per lin. ft. To check the result, note that Fig. 2 indicates a top load without intermediate stiffeners of 370 and Fig. 3 a bottom load of 750, totaling 1,120 lb. per lin. ft.

To complete the design, assume the tank is to be 4 ft. wide and 20 ft. long of welded construction throughout. The stiffeners will be rolled sections, fully welded together at the corners to insure continuous action. When the same section is used for the side and end members of a continuous stiffener, the negative moment at the corners is $w(L^2_1 - L_1 L_2 + L^2_2)/12$ where W is the load in lbs. per lin. ft. and L_1 and L_2 are the lengths of the sides of the tank.

Thus, the negative (corner) moment in the upper stiffener is 3,780 ft.-lb. and the max. positive moment at the middle of the long side is 2,970 ft.-lb. Assuming an allowable unit stress of 18,000 psi., the section modulus required is 2.52. A 5-in. 6.7-lb. channel, having a section modulus of 3, will be selected, provided the deflection is not excessive.

The section modulus required for the lower stiffener, found by proportion (2.52 × 600/135), is 11.2 A 9-in. 15-lb. channel with a section modulus of 11.3 will be suitable.

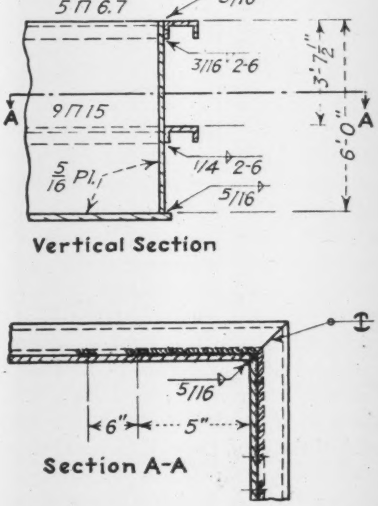

Fig. 4. For the 6-ft. deep tank designed as a typical example of the use of the charts, channels are selected as stiffeners and all connections are welded.

To provide for expected corrosion, $\frac{1}{16}$ in. will be added to the computed thickness of plate, making the final thickness of the side and end plates $\frac{5}{16}$ in.

When the tank bottom is to rest directly on the floor, the bottom plate may be of the same gauge as the sides, although frequently it is made a little heavier. When it is supported on beams, the thickness must be computed to resist the pressure on the bottom plate.

Construction details are shown in Fig. 4. Channels were selected for this example because they are well adapted for duty as stiffeners, but almost any rolled section providing the required strength and stiffness can be used.

Refuse Disposal May Be Charged on Water Bills

Recent Minnesota legislation permits first class cities of that state to finance refuse collection and disposal through service charges collected on water bills or sewage disposal bills rendered to owners, lessees or occupants of property. In each case a "Rubbish Disposal Fund," separate from all other city funds, must be established.

Also authorized by the act is collection of unpaid charges by civil court action or as taxes against the property receiving the service.

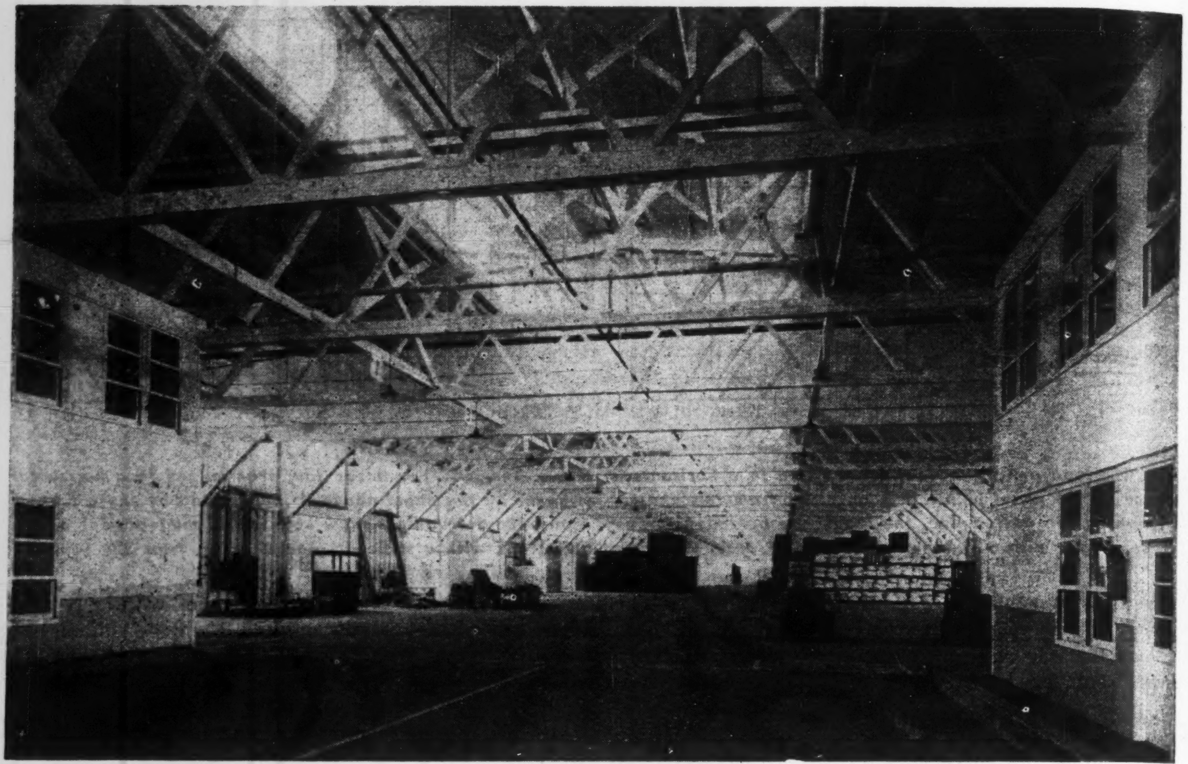

Fig. 1. Fire curtains in the roof trusses and under the deck, with sprinklers and non-flammable siding, alleviate fire hazard.

Seattle Freight Pier Has Modern Details

Contents in Brief — *Pier 42 on the Seattle waterfront, a two-shed, timber-frame structure, has outer corner dolphins, sliding doors under which driving rain cannot pass, solidly anchored mooring cleats, and other features of design reflecting practical experience in pier operation.*

In planning the recently completed pier 42 on Elliott Bay, the Port of Seattle Commission drew upon a broad background in waterfront freight handling experience to develop a design as well suited to the site and requirements as materials available in wartime would permit. An earth-fill support was chosen because sufficient fill material would result from dredging the two slips. The dredged material was a fine river sand shot with a very small amount of clay. In amount it was sufficient to provide a solid support for a large portion of the pier including a wider area for depressed tracks than would have been economical otherwise.

During wartime the possibility of a steel frame for the superstructure was out of the question but this was not serious in a region where timber is plentiful and can be delivered without a long freight haul. The over-all dimensions of the pier are 396x1,019 ft. In this area are two one-story warehouses or transit sheds, 110x981 ft. in plan, each of which is flanked on the water side by an apron 32 ft. wide. The area between the two sheds is finished to a grade 3½ ft. below the level of the shed floor, thus providing space for a 10-ft. truck platform extending the full length of each shed and a central, depressed track area 92 ft. wide.

Steel sheetpiling of "Z" section could be obtained in 60-ft. lengths and this was driven to serve as a bulkhead for the fill. The piledriving was not begun, however, until dredging operations had built enough of the fill at the outer end to provide needed support for the piling. At the northwest corner of the pier when the work started the water was some 60 ft. deep. When enough of the fill had been placed the bulkhead was constructed, driving the sheetpiling down through the fill material. The remainder of the fill was then pumped in behind the bulkhead.

The portion of the fill outside the bulkhead (see Fig. 2) was trimmed off to a 2:1 slope and faced with riprap increasing from a minimum thickness of 2 ft. near the toe to about 9 ft. at the steel piling. The riprap surface was made with a slope of 2½:1. Including a thickened section at the toe to give stability, this riprapping, 85 ft. wide, measured along the slope, required 15 cu.yd. per lin. ft.

Inside the bulkhead the fill was arried to a grade that could be finhed off with paving at El. 19 in the ed area and 3½ ft. lower in the cenal area to be occupied by depressed ailroad tracks. Piling used for buildg footings, deadmen, etc., inside the ulkhead was untreated and all piling utside the bulkhead was creosoted nder the American Wood Preservers ssn.'s specifications for a 12-lb. eatment.

Each pile was driven to 18 tons' earing value under the *Engineering ews Formula.* Many of the piles eveloped this resistance, wholly by kin friction, only after a penetration f 50 ft. or more. Piles varied in ength from 82 to 120 ft. About 500,00 lin. ft. of piling was used.

All caps, stringers and decking exosed to the weather were treated with reosote or chromated zinc chloride. n general, the policy was to use creoote for treating timbers over 6 in. in east dimension and chromated zinc or those under 6 in. However, it was emembered that creosote is a solvent or asphalt and care was taken to lace no creosoted timbers in direct ontact with asphalt paving. All deck urfacing on outdoor pavement conists of asphalt plank panels ½ in. hick.

Building footings in the filled area onsist of concrete piers under each olumn, supported on four wood iles. Each pier is a slab 2 ft. thick, sually about 4½ ft. square but in all ases of a size such that concrete extends 8 in. beyond the outermost edge of the piles. The piles project vertically about 6 in. into the concrete pier or cap. By way of longitudinal bracing between concrete footing piers on the depressed side of each transit shed, reinforced concrete beams 1 ft. wide and 2½ ft. deep extend from pier to pier just below floor level.

Transit sheds

At the inshore end of each transit shed and on either side of the main roadway entrance there are two stories, of offices, rest rooms and space for such utilities as the automatic heating plant, electrical transformers, etc.

The shed roofs are carried on timber trusses of 110-ft. span with a clearance of 21 ft. under the bottom chord. These trusses are 19 ft. high and the bottom chord, a laminated member, consists of four pieces of 3x12 fastened together by 4-in. split ring connectors, spaced on 12-in. centers and held by ⅝-in. bolts.

Automatic sprinklers are located in the roof trusses. A similar automatic sprinkler system under the portion of the pier supported on piles is to afford protection from fires that might be spread by burning liquids such as oil or gasoline.

Additional fire protection is afforded by the draft curtains built across the sheds in the roof trusses and also among the piles below deck level. These curtains, placed at 100-ft. intervals longitudinally, consist of doubled 2-in. tongue and groove, with staggered joints. Curtains in the roof trusses have plasterboard between the two layers of T. & G. The draft curtain below the wharf deck extends down to within 1 ft. of high water level. These draft curtains were fitted in tightly around all structural members that they encounter. The 10-ft. truck platforms extending the full length of the sheds on the inner side are under the shelter of a marque slung by ⅞-in. tension rods on 20-ft. centers.

Windows give exceptionally good lighting in the sheds. High windows extend the full length of both sides above the sliding door tops. With the white finish on the shed interior and the windows at high level in the monitors, the entire interior is well lighted even when the doors are closed.

Specifications for the building walls were written to require corrugated cement-asbestos sheets at the front end and galvanized iron on sides and doors. Because of wartime shortage of materials, however, the best that could be had was asphalt-covered corrugated iron sheets. To give this siding additional protection and rigidity it was backed up on the inside with diagonal sheathing of 1-in. shiplap. Galvanized bolts with lead washers on the outside were used for fastening sheets to sheathing. The roof consists of 2-in. sheathing laid on purlins spaced 10 ft., surfaced with 80-lb. asphalt impregnated asbestos roofing felt.

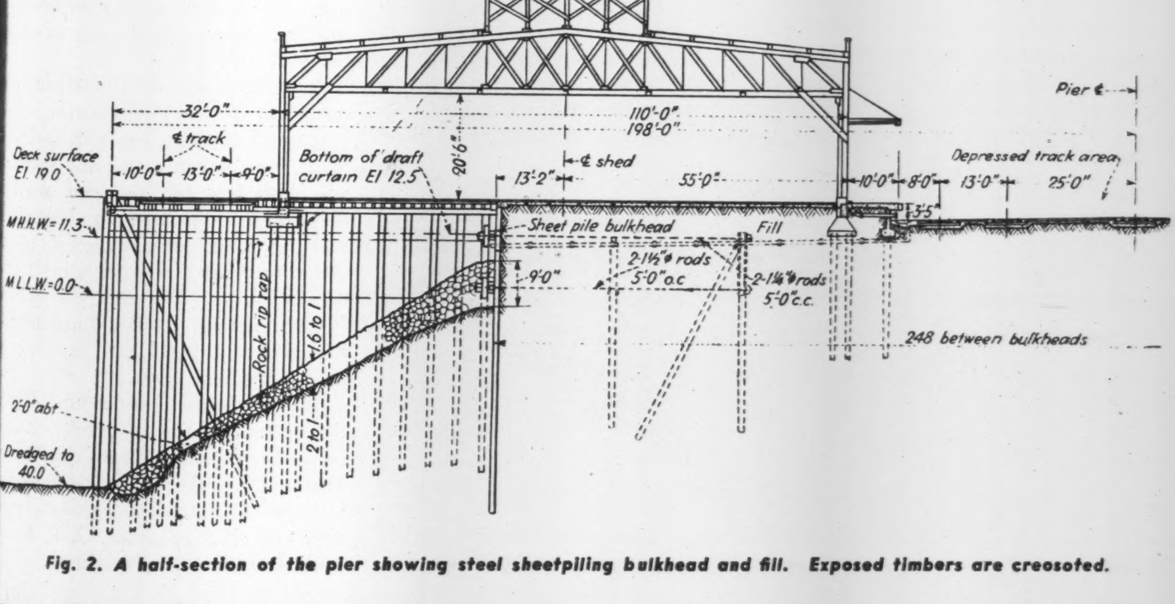

Fig. 2. A half-section of the pier showing steel sheetpiling bulkhead and fill. Exposed timbers are creosoted.

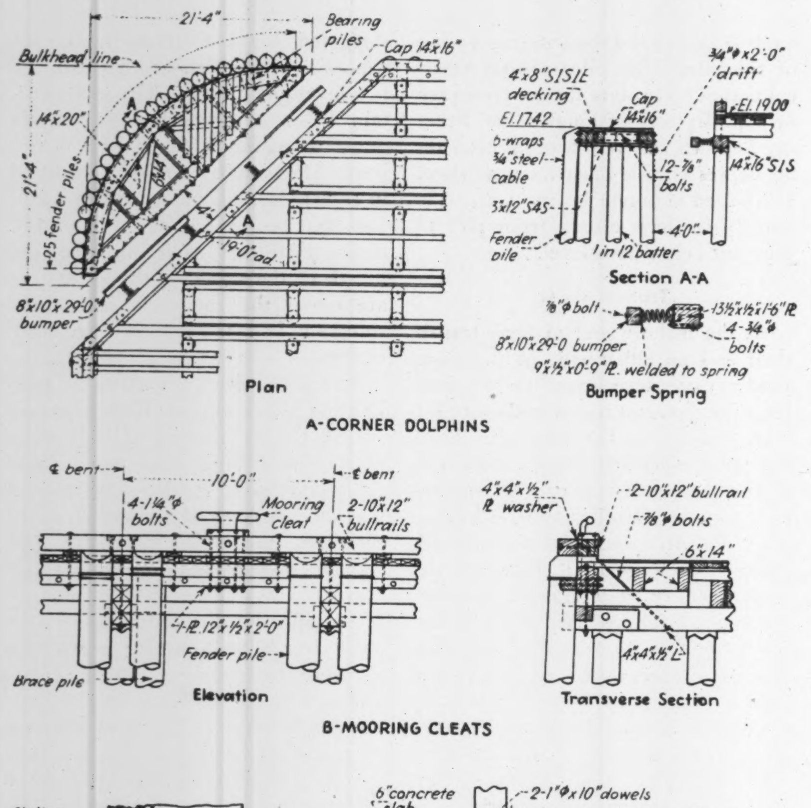
21'-4"
Bearing piles
Cap 14"x16"
Bulkhead line
14"x20"
21'-4"
25 fender piles
A
A
19'-0" rad.
8"x10"x29'-0" bumper
Plan
4"x8" S1S1E decking
Cap 14"x16"
3/4"φx2'-0" drift
El. 19.00
El. 17.42
6-wraps 3/4" steel-cable
12-7/8" bolts
14"x16" S1S
3"x12" S4S
Fender pile
1 in 12 batter
4'-0"
Section A-A
7/8"φ bolt
13 1/2"x1/2"x1'-6" Pl.
4-3/4"φ bolts
8"x10"x29'-0" bumper
9"x1/2"x0'-9" Pl. welded to spring
Bumper Spring
A-CORNER DOLPHINS
℄ bent
10'-0"
℄ bent
4-1 1/4"φ bolts
Mooring cleat
2-10"x12" bullrails
4-Pl. 12"x1/2"x2'-0"
Fender pile
Brace pile
Elevation
4"x4"x1/2" Pl. washer
2-10"x12" bullrail
7/8"φ bolts
6"x14"
4"x4"x1/2" L
Transverse Section
B-MOORING CLEATS
Sliding door
4"x8" planks
1/2" asphalt
1/4"x5" plate dapped into door
1/2"φ bolts 1'-0" o.c.
Pier floor
4"x4"x1/2" L's
1 1/2"x2" spacer lugs fillet welded
2" asphalt
4"x4" laminated
C-SLIDING DOOR THRESHOLD
6" concrete slab
2-1"φx10" dowels
Bldg. line
Column footing
1'-0"
4-pile conc cap 4.5' square
Fill
8"
El. 15.50
Depressed track area
2'-0"
3"
18"
1/2"φ bars at 6" both ways
D-BUILDING FOOTING, DEPRESSED TRACK SIDE

Fig. 3. Details of (A) dolphins at the outer corners of the pier, (B) well-anchored mooring cleats, (C) weatherproof sills for sliding doors, and (D) building footings.

To provide a safeguard against the damage frequently caused at the outer corners of a pier by vessels breasting against the structure while turning under the influence of wind or tide, corner dolphins were built at the outer ends in such a way that they are entirely free of the pier but will thrust against it when pressed. These dolphins were built of 120-ft. piles combined in a cluster that, under horizontal pressure, leans in against a bumper on the pier backed by four sets of triple coil springs. Chains prevent rebound from reaching a dangerous amount.

Particular attention to mooring cleats resulted in a design that affords adequate strength without excessive metal above the bull rail and with a substantial bolt anchorage that can resist any pull the cleat would be expected to withstand.

Sliding doors in the sheds are designed to prevent rain from driving beneath them with attendant risk of damage to stored freight. This is accomplished by a slot in the threshold into which a steel plate fastened along the bottom of the door projects downward. The plate constitutes a baffle, stopping inflow of water without in any way interfering with the free movement of the door.

Paving on the portion of the pier supported on piles consists of a 2-in. asphaltic surface laid over laminated 2x4s. On the filled area the paving is 1½ in. of asphalt on a 6-in. concrete slab. In the depressed track area there is 3 in. of asphalt on 6 in. of crushed rock base.

The two railroad tracks on the aprons, 32 ft. wide, are spaced 13 ft. between centers and this same spacing is used as a minimum in the five tracks extending the full length of the depressed track area between the sheds. At the outer end of this depressed area the railroad tracks come to stub ends but motor trucks and other freight-handling equipment can move up on a ramp of easy grade to the higher level of the apron across the pier end.

A most convenient scaffold was made of pipe and channel iron bolted together for convenience in taking it apart for storage inside the shed. It was used first for installing window sash, then for putting up sheet metal and its permanent assignment, in addition to incidental service, is on window washing. The sections can be bolted together or taken down quickly and working platforms are laid at any convenient level.

The pier, which cost a total of $2,800,000 exclusive of land, was designed by the engineering department of the Port of Seattle Commission, Col. W. C. Bickford, general manager and chief engineer, G. T. Treadwell, assistant chief engineer.

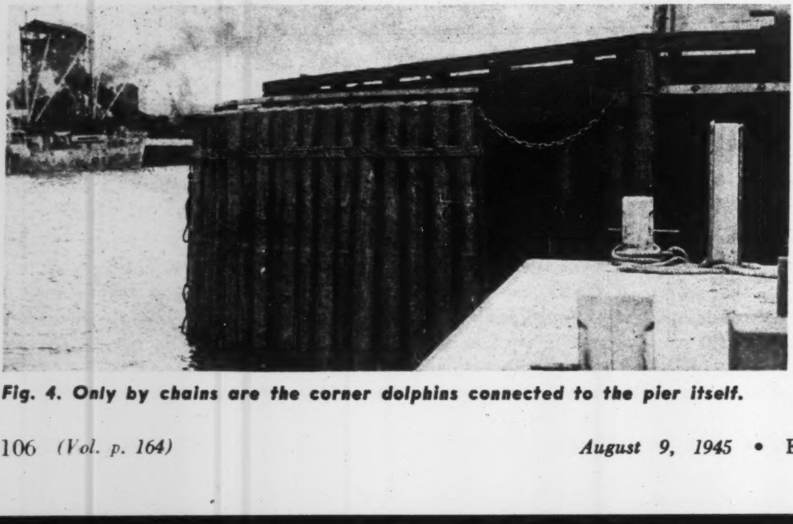

Fig. 4. Only by chains are the corner dolphins connected to the pier itself.

Court Upholds Engineers Right to Control Contract Construction

THE RIGHT OF THE ENGINEER on a construction job to use wide discretion in interpreting the contract has been reaffirmed by the Supreme Judicial Court of Massachusetts. That court has held that a contractor is not entitled to additional compensation even for decisions that are "unreasonable and unnecessary" so long as those decisions were no more than could be called for by honest engineering judgment and were not made in bad faith.

The litigation that occasioned this statement arose out of work performed during 1937 and 1938 by the Benjamin Foster Co. of Philadelphia in the construction of Winsor Dam, an earthen embankment about one-half mile long and rising 170 ft., built in connection with the Quabbin Reservoir, of the Metropolitan District (Boston) Water Supply System (*ENR* May 19, 1938, p. 709).

The case was heard by an "auditor" whose findings of fact were to be final, and unless shown inconsistent or erroneous in law, were binding, except for certain rights of review, upon the trial court and upon the Supreme Court. The auditor filed a report on questions of liability only and the trial judge ruled that the contractor was not entitled to recover. The Foster Co. appealed to the Supreme Court and the latter sustained the trial judge's findings with an opinion in which the following excerpts are of interest and importance to engineers and contractors on construction.

Statements of the court

"It is readily apparent that the safety and usefulness of a structure of the kind described, with its appurtenances, are dependent upon the constant supervision by skilled engineers of the details of the work. . . . Accordingly, it is not surprising that the contract throughout contains provisions worded in various ways requiring in effect that practically all of the work . . . shall be performed according to the orders and to the satisfaction of the chief engineer or his assistants. . . .

"The contract itself provided a method by which questions of interpretation should be determined. It contained a clause that the engineer should decide all questions which . . . (might) arise as to the interpretation of the plans and specifications . . .

"Comprehensive as these powers are, they did not go so far as to authorize the engineers to do anything whatever that they might see fit. These powers are not so extensive as to enable the engineers to abrogate the contract which the parties executed; nor did their inclusion in the instrument prevent the creation of a contract in the first place. The purpose of such powers is to maintain control over the work as it progresses by the persons selected and to secure flexibility in adapting means to ends. The discretion committed to the engineers must be exercised within the framework of the original contract and for the purpose of carrying out the work originally intended.

"The engineers could not substitute for the earthen dam at the place specified a masonry dam at some other point. Changes ordered may be important and in themselves substantial, but the parties must be deemed to have intended that when viewed against the background of the work described in the specifications as a whole; they must be directed to furthering the original design and must not be destructive of that design or disproportionate in size or amount.

"In our opinion all of the orders and decisions of the engineers of which the contractor complains were within the scope of the powers conferred upon them by the contract. . . . The embankment was not to be built to conform to the borrow pits. On the contrary, all borrow pits used must conform to the requirements of the embankment, meaning the embankment as modified by any orders the engineers had power to give. . . .

"Since it appears that the orders of the engineers were within the scope of powers granted to them as defined by the contract, the only remaining inquiry is whether they have actually exercised the judgment committed to them without compulsion, deception, or fraud on the part of others and in good faith on their own part. A wholly arbitrary or whimsical or irrational decision might indicate that there had been no true exercise of judgment upon the problems presented. So, too, if the engineers were misled and so far misapprehended the case that . . . (they) failed to exercise . . . (their) judgment upon it. . . .

"In several instances the auditor has found that the engineers decisions were unreasonable and unnecessary but, in an exhaustive report prepared with the greatest care he has refrained from going farther. It is obvious that his restraint was intentional. When he said unreasonable and unnecessary he meant no more than (in his opinion, formed from the evidence before him), not in accordance with, or demanded by, good engineering judgment. . . . There is no finding that any of the decisions complained of was arbitrary, capricious, or tainted by compulsion or fraud. Our examination of the subsidiary findings does not persuade us to go farther than the auditor went. . . . The case must therefore be dealt with on the footing that all decisions of the engineers were made in the actual free exercise in good faith of their own best judgment.

Engineers opinion recognized

"Neither reasonableness in the ordinary sense nor necessity determine the limits of the engineers' powers or the validity of their exercise. This is not a case where work is to be done to the satisfaction of a party to the contract and where the contract is interpreted, if possible, to means reasonable satisfaction. . . . Here the engineers, at least with respect to the decisions complained of, are made quasi arbitrators by whose judgment the parties agree in advance to be bound. . . . Their decisions are not to be controlled by any extrinsic standard of reason or necessity. That would merely substitute the judgment of court or jury for that of the engineers. . . . For a court to substitute its own lay opinions on such matters, however well it may think itself informed through evidence, for the opinions of the engineers in the field to whom the parties have entrusted such decisions would be directly contrary to the terms of the contract and in the long run likely to produce unsound results."

Water Supply on Pacific Islands

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***Contents in Brief**—Seabee "know-how" in meeting water supply problems on islands in the Pacific has been an important element in advancing our military gains. This was exemplified at Guadalcanal where initial supplies were obtained from shallow wells following which drilled and surface supplies were developed. On Emirau Island coral and limestone formations were tapped to provide abundant sources of water. Filtration and chlorination facilities were improvised on several occasions to meet special conditions.*

ADEQUATE WATER SUPPLY is essential to any military operation, surpassing in importance the flow of food, supplies, or even ammunition. Of the numerous Seabee units with which the writer has worked or come in contact during the past two years' duty in the Pacific, none has suffered from a lack of sufficient water. In every case, with the resources at hand, they have met and overcome the problem of water supply. Often there has been a lack of proper equipment and materials — especially, well-drilling rigs, pipe, and fittings — but Seabee ingenuity has turned out gadgets and improvisions by the score to meet every need.

Our naval construction battalion's initial water problem occurred in April 1943 while en route from the United States to Guadalcanal aboard a Dutch merchant ship. When the ship's freshwater supply ran low one of the Seabees' 250-gph. distillation units stored on deck was quickly put into operation. For ten days, working two men per 6-hr. watch for four watches daily, the Seabees were able to furnish the ship's tanks with some 5,000 gal. of converted seawater per day.

Initial supply on Guadalcanal

Our campsite on Guadalcanal was located about a mile and one-half from the Tenaru River. As soon as a contingent of Seabees went ashore they set to work with a Navy pontoon loaded on a truck. Water from the Tenaru River was pumped into this pontoon (capacity, about 1,250 gal.) and hauled to the campsite. There it was treated with the aid of two 15-gpm. portable purification units and stored in other pontoons, ready for drinking and use in the galley.

At a site near camp, a 20-ft. shallow well was soon dug, capable of producing 60 gpm. of potable water. For this excavation a clamshell was

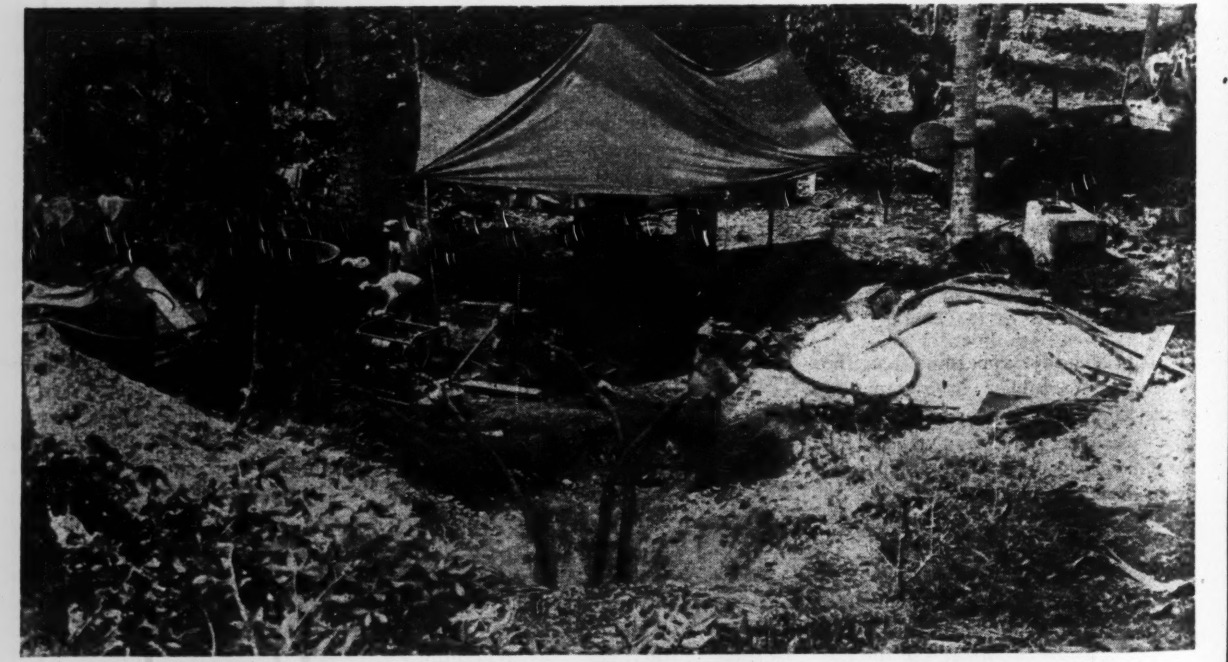

Fig. 1. Shallow wells on Emirau Island tapped the water table in a coral sand that was overlaid by several feet of impervious limestone and coral. Of excellent quality, the water required only chlorination treatment. The well installation shown served as one of the primary water distribution points following the invasion and later was improved for permanent service.

used. When the well had been cribbed, a 3-in. centrifugal pump, powered with a 1-cyl. gasoline engine, was put into operation. Within a few days a complete water system for our camp, including showers, pontoons on towers (for storage), and a pipeline to the filtration units, was installed. Pontoons were also erected on towers for treated water storage.

Our Seabee welders deserve a great deal of praise for the rapidity with which this work was accomplished. In the early stages of the campaign in the Southwest Pacific, many materials were extremely scarce, especially pipe and pipe fittings. If an adequate amount of a certain size pipe could be obtained, invariably there would be no fittings to go with it; if fittings of a particular size were available, there was no pipe of that size to be had. The welders "turned to" and made all necessary tees, elbows, reducers, etc.

Supplementary supplies

To supplement our supply and provide for drought or any other eventuality, another shallow well was excavated and developed. After several months of pumping, these wells developed a slightly unpleasant odor, likely because of the large amount of decaying vegetation and fungus in the ground-and surface-water. To remedy this, aeration pans (built similar to an ordinary cooling tower, except with more baffles) were installed at each well; although requiring the use of another pump, these were very satisfactory and completely freed the water of disagreeable odors.

Throughout the island, other outfits —Army, Navy, and Marines—operated water distribution points on the Lunga, Tenaru, Matainkau, Nalimbu, and Metapona rivers. Water pumped from these rivers was treated either by a battery of 15-gpm. portable filtration units, or with 80-gpm. mobile units.

During heavy rains, however, when the rivers became very turbid, no great amount of water would pass through the filters. To remedy this, infiltration galleries—consisting of a series of empty oil drums welded together and perforated — were constructed in the sandbars. These proved quite adequate, and even during rains the turbidity of the water pumped from these galleries was low.

Later, the Seabees in conjunction with the Army Engineers (using two of the Engineer's drilling rigs—a portable 4-in. rotary and a 6-in. cable tool) started drilling deep wells in likely locations throughout the island. At this period (the fall of 1943) very little information on the geology of Guadalcanal was available, and the probability of striking fresh water was a hit-or-miss affair.

However, a number of good deep wells were developed and most of them were full-flowing artesians. This was fortunate, as there were only a few deep-well pumps on the island, and centrifugal pumps had to be utilized.

The well water was fairly potable and no filters were used. With a chemical pot feeder and some ½-in. hose salvaged from a discarded 15-gpm. portable purification unit a device for introducing calcium hypochlorite solution into the suction line of the pump was made. Into this line was inserted an improvised injector, with a length of ½-in. connecting hose running to the outlet of the pot feeder; another length of this hose connected the inlet of the pot feeder to the storage of calcium hypochlorite solution. Dosage was controlled by regulating a needle valve and making spot tests with a color comparator, using orthotolodine as a reagent.

Deep well construction

The best deep well developed was in the Kukum Beach vicinity. With a cable tool rig, the Seabees began digging at a spot about 200 yd. from the shore—elevation about 20 ft. above sea level. Drilling through the hard coral, impervious limestone, and volcanic clay and rock was slow and difficult. After many days, at a depth

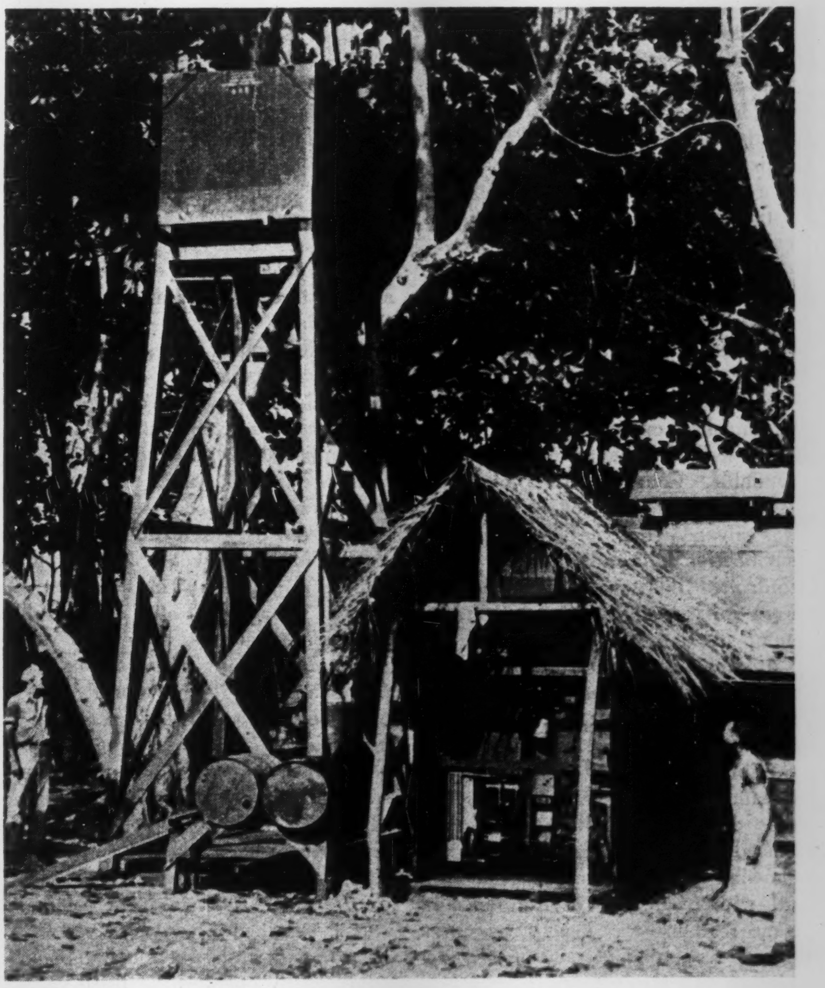

Fig. 2. Steel pontoon adapted for elevated water storage. The pontoon, which is resting on a 20-ft. timber tower, holds 1,250 gal. of treated water.

of about 380 ft., water-bearing sand and gravel was encountered. Drilling was dicontinued temporarily to insert an 8-in. casing, the lower 40 ft. of which was perforated.

Then drilling was resumed, halting only at regular intervals to lower the casing, until at a depth of about 420 ft. an impervious rock strata was encountered. After thorough surging, soft, chloride-free, potable water flowed from this well at the rate of 20 gpm. A concrete-floored pump house was constructed over the well and a 150-gpm. deep-well pump, powered by a 4-cycl. gasoline engine, was installed. The supply was so plentiful that even after many hours of pumping, the well always returned to its 20-gpm. artesian flow shortly after the pump was shut down.

It was decided to use the water from this well for supplying ships in the channel as well as service units in the area. To do this a 4-in. steel pipeline was laid to Kukum Pier nearby, where valved 1½-and2½-in. hose connections were installed on a common header. In this way, the pump could deliver water directly to the ship. Water continued to be by-passed to a tank erected near the well for distribution to tank trucks and trailers.

Chlorine put in at pump discharge

The Seabee method of chlorinating this water was unique. There was no practical way of introducing calcium hypochlorite to the suction side, as the impellers of the pump were down in the well. No line chlorinators were available. Consequently a complete direct-feed chlorine-control apparatus was salvaged from an 80-gpm. mobile purification unit and installed. Thus, controlled dosages of chlorine gas were injected into the water at the pump discharge.

It was necessary to devise some method for checking the pumping rate. To do this, a 2-in. orifice was installed in the 4-in. discharge line; two pressure gages, one on the upstream side of the orifice and one on the downstream side, were then placed on the discharge line. A graph showing the flow of gallons per minute with respect to the difference in gage readings was kept. Thus, at a glance at the gages and the graph, one could easily determine the output of the pump per minute.

The Seabees' improvised gravity filter system put in for Comairsopac on Guadalcanal is worth noting. An infiltration gallery in a Lunga River sandbar near the campsite supplied the water for this system, and two pumps lifted it into a 3,000-gal. wood stave tank. This tank, into which some wood baffles had been built, acted as a coagulation and sedimentation basin.

Fig. 3. One of the 15,000-gal. wood stave tanks on Emirau.

A small pump from a portable purification unit was used to introduce chemicals in proper dosages to form the "floc". Pre-chlorination was also accomplished with the aid of a feeder. This pre-treated water, the flow of which was controlled by a float valve, then passed by gravity into the filter.

This filter was constructed in the following manner: An under-drain system consisting of a 4-in. manifold and 2½-in. laterals, perforated with numerous ⅛-in. holes about six inches apart and staggered at angles of 30 deg. off center, was placed (the holes looking down) about 3 in. above the floor of a 500-gal. wood stave tank. A 4-in. pipe then led from this under-drain to a manifold that had three valved outlets. With this setup, water could run from filter to the clear well or from filter to waste; or, when these two valves were closed, backwash water could be introduced by opening the third valve.

Four layers of round gravel, varying in size from ¼ in. to 2½ in. in diameter were placed around and on top of the under-drain to a depth of about 16 in. No screening wire of any of these sizes were obtainable, and these pebbles had to be handpicked from the Lunga River beaches, which required quite some time. About 28 in. of river beach sand, washed and screened, was placed on top of the gravel, this sand having proved effective in previous trials with the 15-gpm. portable filter units. A circular washwater trough, whose top was about 2 ft. above the sand, was then installed in the top part of the tank. Overflow from this trough ran to waste through valved pipes.

Water from the filter flowed by gravity into the clearwater well, which consisted of two pontoons with the tops cut out. A 6-in. centrifugal pump powered by a gas engine served: (1) to boost water from this clear-water well to the elevated storage tanks; and (2) to pump water at a controlled rate from the clear well through the underdrain for the backwash, when backwashing became neccessary. Later, auxiliary pumps were installed to insure a continued flow during motor trouble and breakdowns.

Post-chlorination was accomplished by introducing calcium hypochlorite in solution form to the suction side of the pump, in the same manner explained previously. This improvised filter unit proved very satisfactory, averaging an hourly output (counting time for backwashing) of about 6,000 gal.

A coral island supply

Our next assignment was on Emirau, located just north of New Ireland in the Bismarck Archipelago area. Very little was known about the geology of the island when we landed there in March 1944, except that it was predominately coral. Its unofficial name, "Squally Island," indicated that there was probably plenty of rainfall, which later proved to be true. Generally, it was believed that there would be a scarcity of fresh water, and distillers would have to be used.

Fortunately, however, this was not true. Fresh water from springs close to the shoreline seeped into the ocean at low tide at practically all the beaches. (Marines and Seabees who landed on D-day used this water, and also operated two stills). One small e with a stream flowing from it the ocean was located, but the er from it proved to be high in content.

s soon as the second echelon of bees landed on D-plus-5, two shal- wells were dug, one on each end the island, and portable purifica- units put into operation. For y days these wells served as main ribution points, from which the erent units trucked water to their ious campsites. Later, they were re fully developed and operated as manent water points.

Campsites were selected for sched- d incoming units, and work was un excavating shallow wells in h of these areas. After re- ted excavations of shallow wells Emirau, it was found that the er-table of the island lay in a al sand under impervious lime- e and coral. This layer of water ged in depth from 1½ to 4 ft. ve sea level at high tide and fairly uniform throughout the nd. All future wells were lo- ed as far from the shoreline as sible, while still keeping excava- at a minimum depth.

Water from these wells proved to pleasant-tasting, practically free of teria and not too hard. It was rless, colorless, and slightly alka- e—the pH value ranging between and 8. Chlorination was the only tment required. This condition ideal, as the use of small portable ration units (though excellent for work) is a slow and tedious pro- , producing too small a volume of er.

During pumping, a very careful k was made on the drawdown of h well, and production was always t well below maximum capacity. this way, the chloride content was t to a minimum.

Shallow wells on the beach

The site selected on Emirau for the bomber strips and camps for sonnel attached thereto was on a teau-like peninsula jutting north- d from the center of the island ranging in elevation from 75 200 ft. Generally, the rim of this teau was a sheer cliff dropping ight to the water below, but occa- ally there was an indentation re the beaches ran at a gradual e as much as 400 yd. into the e of the cliff. Men, lowered down these cliffs to the beaches by rope, cut their way through the jungle with machetes, made surveys, and selected likely spots for wells. Then service roads were carved down the cliffs and through the jungles to these locations so that equipment could be brought in.

Wells average up to 700 gpm.

By the end of May 1944, three large shallow wells about a mile apart had been excavated at the base of this plateau. Their size averaged 15 by 30 ft., with depths varying from 8 to 16 ft. Excavation was by clamshell, aided by blasting, and cleaning and surging accomplished with a 4-in. diaphragm pump. Sturdy pump houses were then constructed over these well shafts and the surrounding terrain was graded and mounded so that no surface water would enter the wells. Production by these wells, as subsequently indicated by pumping records, averaged from 150 gpm. up to 700 gpm. (for the best one), with very little draw-down.

For risers from the wells to the plateau, lightweight 6-in. spiral steel pipe with mechanical couplings was jointed and lowered over the cliffs by cable, then securely anchored. This type pipe was also used for the water main on the plateau and a complete interlocking system among wells was formed.

Eight 15,000-gal. wood stave tanks (all erected to the same elevation) were installed on the plateau at various points along the watermain and tied into it. In addition to providing storage, these tanks acted as standpipes to equalize the pressure.

Laterals of smaller sized pipe, placed to form properly valved loops, were laid from the main to every campsite and to two distribution points supplying water to tank trucks. Risers with valves and hose connections were installed on mains and laterals in strategic locations for fire protection.

Because of the extreme height and distance this water had to be pumped, the small centrifugal pumps normally provided for water distribution systems were inadequate. Instead, 6-in. centrifugal pumps, powered by 6-cyl. gas engines were procured and installed, two at each well. To prolong their life, these motors were operated alternately, with an auxiliary available in case of breakdown.

Calcium hypochlorite solution in controlled dosages was introduced into the water through the suction line in the same manner explained elsewhere in this article.

An electrode signal system for the storage tanks was rigged up by the electricians and wired to the lights in each pump house; when the tanks were one-half full and full, these lights would flash on and signal to the operator. A telephone system connecting the three pump houses was also installed, giving the operators contact with one another at all times.

Because of the possibility of an extended dry spell on the island, it was believed that another well might be needed in the bomber-strip area. In the approximate center of the

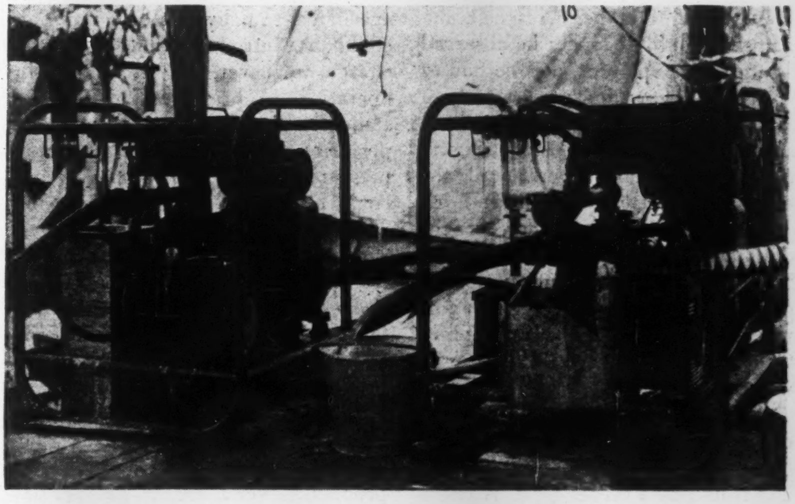

Fig. 4. A battery of portable purification units. Each unit includes complete filtration and chlorination facilities, and is equipped with a gasoline engine.

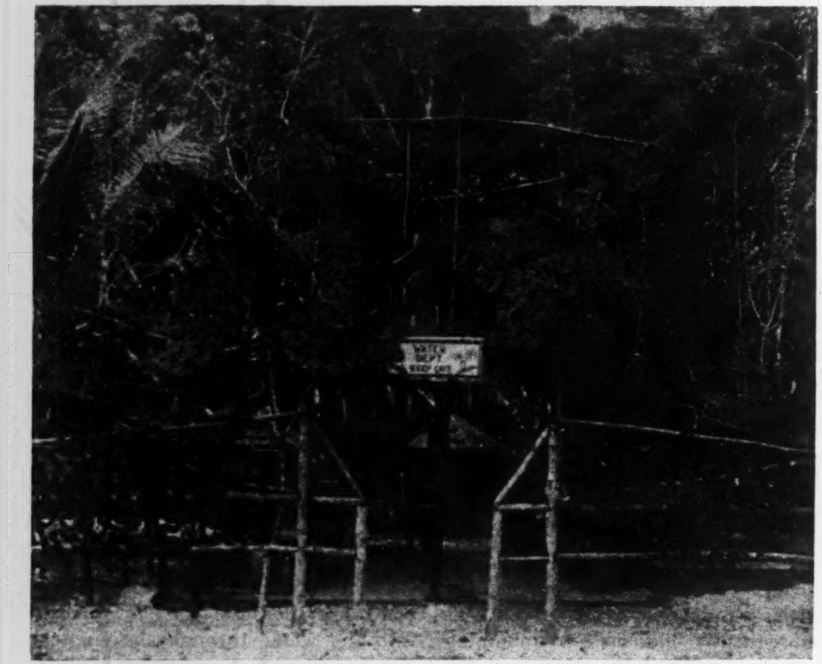

Fig. 5. In the event that the Japs fail to observe the sign reading "Water Dept. Keep Out," the Seabees have effectively camouflaged this purification plant.

plateau was an extremely large natural basin covered with trees and vegetation—a very likely spot to dig. The lowest point in this basin, however, was about 80 ft. above sea level, and no deep-well drilling equipment was available on the island.

For this job, the Seabees moved in a 1½-yd. crane rigged with a clamshell, and excavation of a 3 by 8 ft. shaft was begun. The coral, although quite firm, did not require blasting. Sinking this shaft proved to be quite a feat nevertheless. After a depth of about 18 ft. had been reached, the clamshell could no longer be observed by the crane operator, and he had to "feel" his way down. Water was encountered two feet above sea level after about 16 hr. digging. Digging was continued, however, until the shaft was about 15 ft. below sea level.

Heavy timbers were placed over the shaft and a substantial well covering built. Then, a 60-gpm. deep-well pump, powered by a 1-cyl. engine was installed and the discharge piped through a check-valve to the 6-in. watermain.

A check of the static level and draw-down on the well was accomplished by lowering a float into the well and installing a target gage. A chemical feeder and some ½-in. hose was salvaged from an old 15-gpm. portable filtration unit. Into the discharge line, tapped just beyond the check valve, an improvised injection nozzle was installed. With a length of the ½-in. hose a connection from the injection nozzle to the discharge of the feeder was made and a V-belt pulley affixed to the pump's horizontal driveshaft. Motivation of the feeder was by a V-belt from this pulley to its own pulley.

Hypochlorite dosage controlled

With this setup, a controlled dosage of calcium hypochlorite solution could be introduced into the discharge whenever the pump was in operation. A pressure gage was installed in the discharge line for experiment to determine the maximum pressure against which the feeder could operate. By gradually closing a valve in the discharge line, pressure was increased and an accurate recording of gage readings made. From this test it was found that the feeder could operate satisfactorily against approximately 110 lb. pressure.

Within a little over three months after our forces had landed on Emirau combined wells were capable of producing over 2,000,000 gal. per day without overtaxing their yield or without overworking the pumps—an extraordinary condition for so smal an island.

The writer did not make a thorough inspection of the water suppl system on New Caledonia, and a accurate account cannot be given. I is known, however, that various successful steps were taken by both Seabees and Army Engineers to increas the output of the existing Frenc water system. More and larger main were installed, storage tanks erecte and pumping stations put in. However, conveyance and distributio were the only real problems, as th annual rainfall was adequate and favorably distributed, and numerou streams furnished surface supplies.

In the Monte d'Or area, where large Seabee re-staging base was blueprinted, a separate and complet water system was planned. In thi area, too, there was no water suppl problem, as three streams of crysta clear water flowed from the mountainside nearby. One of these streams ha an average flow of about 500 gpm This stream was dammed and th water piped through a 6-in. steel lin to a 10,000-bbl. steel storage tan erected on the mountain-side. Flo was by gravity and no pumping wa necessary. Chlorinators, hydraulicall operated, were used to chlorinate th water as it entered the tanks. Fro this tank, water flowed by gravit through 6-in. pipe to the distributio systems for the two battalion areas

A similar gravity system on smaller scale was installed for th regimental headquarters. Chlorin was introduced by using a salvage chemical feeder from a 15-gpm. portable purification unit.

Plans had been made to dam th other stream and tie all the supplie together, furnishing one complete system for the entire restaging area; bu the Seabees, with larger and far mor important assignments nearer Toky were removed and the entire restagin base plan cancelled.

Every new landing presents its ow problems; annual rainfalls vary, geological formations are different, an other local conditions are seldo identical. But with careful thinkin a little ingenuity, and some har work, the job of supplying an adequate amount of water to our troop can be accomplished—a job which always of prime importance, no matter where they are located or wh the circumstance.

FREIGHT RATES *and* INDUSTRY LOCATION

A SIGNIFICANT decision, announced by the Interstate Commerce Commission last May, will take preliminary effect on the 30th of August. It will eliminate some of the advantage in freight rates which Eastern shippers have enjoyed over shippers of the South and West.

The decision has been enthusiastically hailed as an Emancipation Proclamation for industrial development in the South and West. It has also been roundly condemned as a meddlesome control measure that ignores valid differences in haulage costs, and recklessly blots out one of the important factors in determining the location of American industry.

Cooler appraisals indicate that the net effect of the rate changes will be far less drastic than predicted by the more passionate advocates or adversaries. Nonetheless, it is important for the business world to be informed both upon the principle at issue, and upon the forseeable consequences of the ICC ruling.

What The Decision Calls For

The Commission's order, unless modified, or successfully contested in the courts, will require: (1) the eventual establishment of a single freight classification, or grouping of commodities for rate-making purposes, for application throughout the United States; (2) a single level of *"class rates"*—or rates established for groups of commodities and primarily applying to manufactured and semi-manufactured articles of high value—in the area east of the Rocky Mountains. This level is to be about 15 per cent higher than the present Eastern scale.

Because it will take some time, probably several years, to work out a uniform classification in place of the three major classifications now existing, a preliminary adjustment is provided.

Under this adjustment the existing classifications will remain in effect, but the rates on articles moving on *class rates* will be increased 10 per cent in Eastern or Official Territory—the area east of Lake Michigan and the Mississippi River and north of the Ohio River. On the other hand, the rates will be reduced 10 per cent on articles moving on class rates in the South and West, and on those moving interterritorially.

What The Problem Was

At the present time there are marked differences in the levels of the basic scales of class rates in the five major rate territories—Eastern or Official, Southern, Western Trunk-Line, Southwestern, and Mountain-Pacific. It is difficult to average the levels of rates, but if the level of the class-rate scale in Official Territory is taken as 100, the levels in the other territories may be roughly considered as follows. Southern, 139; Western Trunk-Line, 128, 146, 161, 184 in Zones I, II, III, and IV, respectively; Southwestern, 161; Mountain-Pacific, 166.

These are over-all comparisons. On many individual articles the differences in levels of rates are greater or less than indicated because of offsetting differences in regional classification schemes. In many cases, the use of exceptions to the classifications and of special commodity rates has reduced the regional disparity in rates. In fact, on some articles, particularly on certain low-grade traffic such as logs, pulpwood, bricks, coal, sand and gravel, the South and the West have actually had lower rates than Official Territory. The rate disadvantage of the South and West has been principally on manufactured articles.

The territorial differences in class-rate levels have complicated the problem of constructing rates from a point in one territory to a point in another. Today, such a rate tends to represent a blend of the levels in effect at the place of shipment and at the destination. Thus manufacturers and dealers in a higher-rated territory are likely to see themselves at a disadvantage when they attempt to sell goods in a lower-rated territory against competition located there.

Now, if differences between territorial rate levels are removed, the *inter*territorial freight-rate problem largely disappears. So it is an important question whether such differences are justified. The Commission has found that they are *not* justified either by differences in transportation costs or by other valid considerations. From that finding came the order to establish a uniform level of class rates and a single freight classification.

The Decision And The Map Of Industry

What effect will this decision have on the location of industry in the United States; and what effect will it have on the economic development of the East, the South, and the West?

Today, many in the West and South believe that their higher class rates have seriously retarded the industrial development of these areas, and promoted the concentration of manufacturing in Official Territory. They point out that Official Territory has over 50 per cent of the population of the country, had nearly 70 per cent of the persons employed in manufacturing in 1940, and accounted for nearly 73 per cent of the "value added by manufacture" in 1939. Boasts of industrial development in the South, and to some extent in the West, in recent years are accompanied by claims that this would have been greater but for the freight rate structure.

Another point gets into the argument. Official Territory is not only the country's most highly industrialized section, but also its greatest consuming territory. It is the market which nearly all manufacturers desire to reach, particularly when they have a surplus to sell. Here again is occasion for an outcry by producers outside of Official Territory against the consequences of their high rate levels and the levels of interterritorial rates. Under the circumstances it is not strange that the South and West have argued long and volubly for mile-for-mile equality in rates.

Those in Official Territory deny that the South and West have been handicapped by the rate adjustment, but at the same time look with apprehension at the loss of their rate advantage.

What's The Effect?

However, now that the ICC's ruling is about to be put in operation, it is time for the colorful statements of the debating period to give way to a sober appraisal of what the consequences are likely to be.

In the first place, it should be noted that the preliminary adjustment will affect only a small fraction of the traffic. Estimates indicate that only about 4 per cent of the full-carload traffic moves on regular class rates. About 11 per cent moves on exception ratings which are not affected by the preliminary order; and about 85 per cent moves on commodity rates, which were not within the scope of the Commission's decision. The proportion of less-than-carload lot traffic affected is much greater, since a large part of it moves on class rates; however, less-than-carload traffic constitutes less than 1½ per cent of the total tons carried.

The permanent rate structure will probably affect more traffic than the preliminary order since, in the establishment of a uniform classification containing more classes than at present provided, many articles now moving on exception ratings are likely to be brought within the scope of the classification, and the same may be true of some articles moving on commodity rates.

But, even if a large proportion of the traffic were affected by the Commission's order, or if the principle of equality in rate levels is eventually extended to much of the traffic moving on commodity rates, these freight-rate adjustments cannot be expected to revolutionize the pattern of industrial location in the United States.

It seems evident that most industries now found in Official Territory are located there for other advantages than that of a lower level of freight rates, undeniable as such an advantage is. Insofar as that is the case, they have little to fear from equalization of the rate levels. For those which have, indeed, been dependent upon preferential rates and otherwise badly located, the removal of the preference and their consequent shift to some area possessing a real locational advantage would be desirable from the point of view of the national economy.

While the high degree of industrial concentration in Official Territory does not rest on such a flimsy basis as a lower level of class rates, the Commission's decision does remove one existing handicap to the growth and development of the South and West. The new adjustment should permit all sections of the country to develop the industries for which they have natural advantages. It should contribute to a sounder regional specialization than we have heretofore had.

This decision will neither destroy the economy of the industrial East, nor will it, overnight, assure the industrial flowering of the South and West. It constitutes one sound step toward establishing that equality of opportunity for all sections of the country which is essential to a nation that bears the proud title of The *United* States.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 38TH OF A SERIES

Large Triaxial Testing Machine Built by Bureau of Reclamation

R. F. Blanks and Douglas McHenry

Chief, Engineering & Geological Control & Research Division, and Chief, Basic Structural Research Section, Office of the Chief Engineer, respectively, U. S. Bureau of Reclamation, Denver, Col.

Contents in Brief**—*New fields of research into the strength of concrete and rock under the load conditions produced at large dams are opened by the triaxial testing machine built for the Denver laboratory of the U. S. Bureau of Reclamation. The machine can test specimens up to 6x12-in. cylinders under axial and lateral loading of 125,000 psi. Under these extreme conditions the testing machine carries an internal load of 110 million pounds.***

THE RESISTANCE of concrete and rock to shear failure, the shear factors of safety provided in design, the effect of internal pore pressure on the strength of concrete and rock, and the effect of uplift pressures at joint, crack, and contact planes have been controversial questions in the design of large gravity-type dams for the past three decades. In 1932 the Board of Concrete Consultants of the Bureau of Reclamation recommended that an extensive investigation be made of these factors as a part of the research in connection with the design and construction of Boulder Dam. Planning was initiated at that time for a triaxial testing machine for concrete, but the technical difficulties involved in the design and manufacture were so great that it was not until 1940 that construction was started. The machine is now assembled and is operating in the laboratories of the Bureau of Reclamation in Denver, Colo.

Preliminary studies showed that the most feasible method of testing concrete under triaxial loading involved the use of 6 by 12-in. cylindrical specimens, loaded axially by an hydraulic ram and laterally by direct fluid pressure. As the studies progressed, it became evident that an adequate investigation of the strength of concrete and of rock cores two or three times stronger than concrete would require a machine of unprecedented design. Because it seemed entirely probable that another testing machine like it might never be built, it was decided to design the machine for the maximum axial loading and lateral pressure capacities that can be practicably obtained with present knowledge of materials and fabrication methods, and thus to assure that the loading capacity would be adequate for present and future needs. On this basis the upper limit for both axial and lateral loading on the 6 by 12-in. cylinders was set at 125,000 psi.

This pressure is considerably greater than that developed in the barrels of large guns, but the problems encountered were similar to those involved in the design, manufacture, and testing of heavy ordnance. On that account a large part of the design work, all of the preliminary testing in connection with design, and some of the fabrication were carried out at the offices and plant of the Watertown Arsenal in Massachusetts.

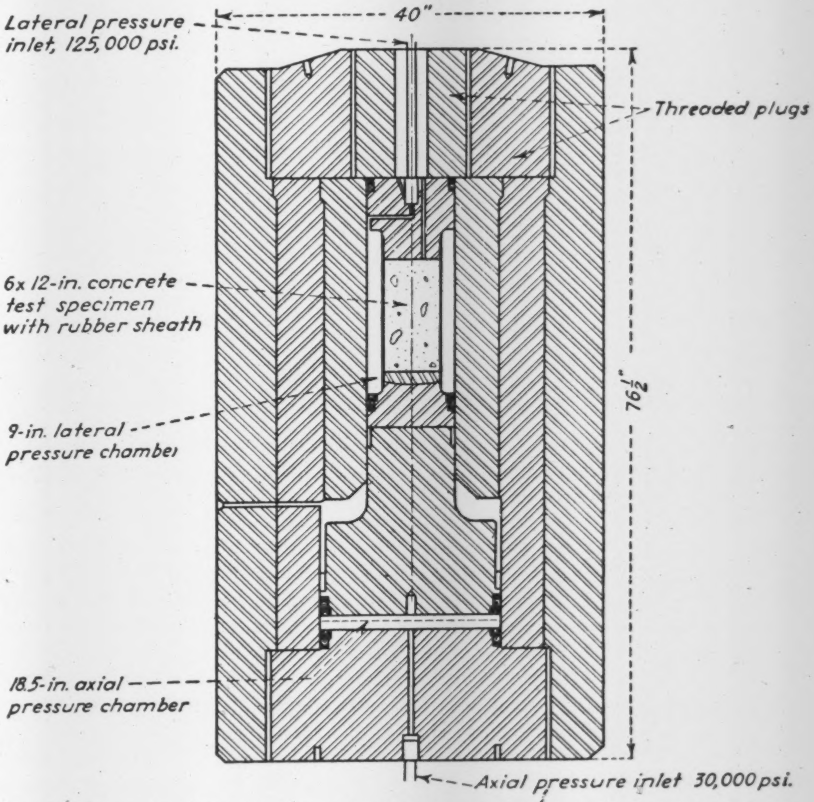
Lateral pressure inlet, 125,000 psi.
40"
Threaded plugs
6x 12-in. concrete test specimen with rubber sheath
76½"
9-in. lateral pressure chamber
18.5-in. axial pressure chamber
Axial pressure inlet 30,000psi.

Fig. 1. Main unit of the testing machine designed to withstand an internal bursting load of 110,000,000 lb.

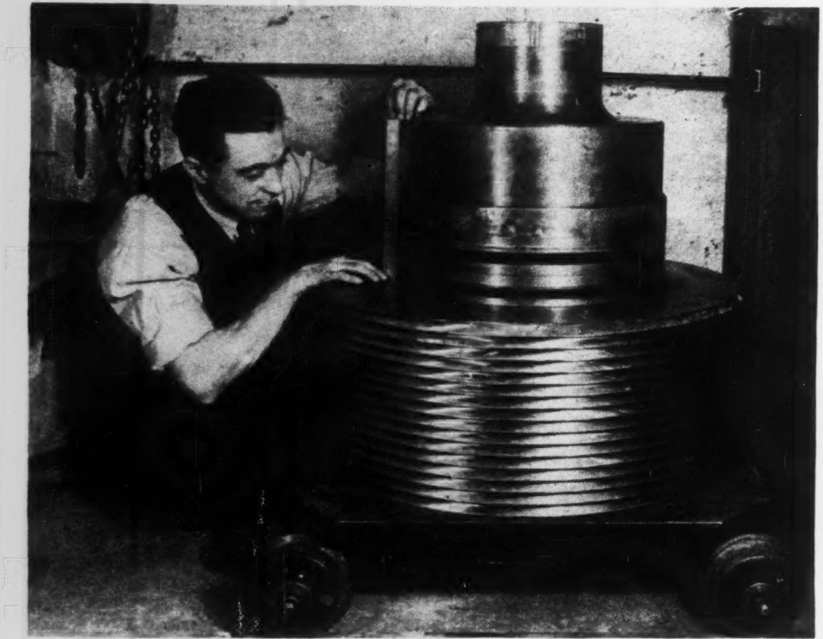

Fig. 2. Base plug and ram of the triaxial testing machine. The plug and ram are of alloy steel, the wearing rings are of high-tensile bronze and the packings are of leather, U-shaped.

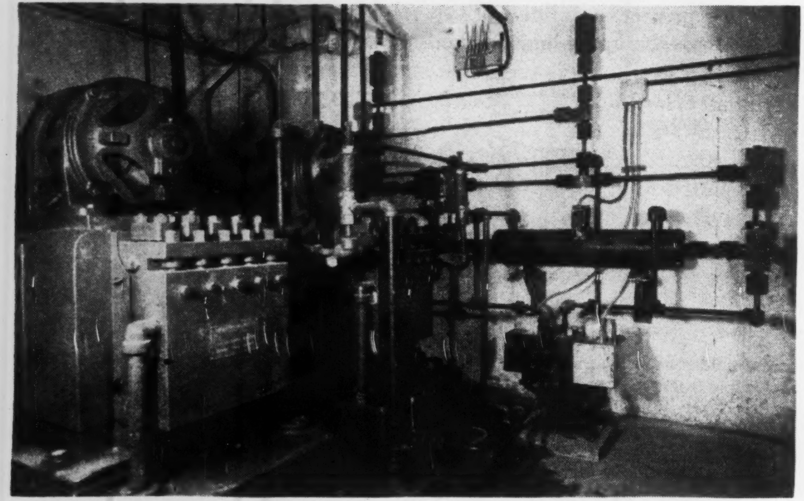

Fig. 3. Pump room for the pressure system. Shown are the two 5,000-psi. pumps, one of the pressure intensifiers with a solenoid-operated 4-way valve, and the 125,000 psi. pipe and fittings.

The main unit of the testing machine, assembled with a concrete cylinder in place for testing, is shown by Fig. 1. If this concrete cylinder is stressed to the full capacity of the machine—125,000 psi. both axially and laterally—it will be supporting a total load of 35 million pounds, and the testing machine itself will be carrying a total internal load of 110 million pounds. To withstand this bursting load the walls of the testing chamber are 15½ in. thick and are made of three concentric shrink-fit cylinders of alloy steel. Further safety against rupture of the chamber has been provided by prestressing the interior wall in compression by the auto-frettage process of cold working under hydraulic pressure.

The pressure chamber is accessible from the top for insertion or removal of specimens by unscrewing the smaller of the two concentric threaded plugs. The ram may be removed by unscrewing the threaded plug at the bottom of the machine (Fig. 2). Means are provided for using electric instruments in the pressure chamber or in the specimen itself for measurement of deformation or pore pressure, and special loading blocks and load measuring devices are available to facilitate the study of smaller specimens.

Independent pressure systems

The pressure systems for the axial and the lateral loading are independent, each consisting of a 5,000-psi. variable delivery pump, a solenoid-controlled 4-way valve and pressure intensifier, a manganin-wire pressure gage, and the necessary high-pressure valves, pipe, and fittings. The pressure fluid (kerosene) is piped from the pumps to the pressure intensifiers through double-extra-strong steel pipe, and from the intensifiers to the testing machine through alloy steel tubing ¾-in. outside diameter by $\frac{1}{16}$-in. bore.

Fig. 3 shows the two pumps, one of the pressure intensifiers, and the high-pressure pipe and fittings. Much of this equipment, including the intensifiers, the high-pressure fittings, and the manganin-wire pressure gages, had been developed previously at the Watertown Arsenal.

Shearing strength tests

Determination of shearing strength provides an example of the type of testing to which the new machine is adapted. It is generally recognized that the so-called direct methods of measuring shearing strength (as by punching or similar means) involve large uncertainties because failure is produced under complex stress systems which influence both the shearing stress and the shearing resistance to an indeterminate extent. In the triaxial shearing test, only uniform compressive loads are applied to the cylindrical specimen, and these loads produce shearing failure on a surface over which the shearing stress is (for all practical purposes) uniformly distributed. The shearing resistance is, of course, influenced by the normal stresses which act over the surface of failure; but when several specimens are tested to failure under various combinations of axial and lateral loads the effect of the normal stress may be evaluated and, if de

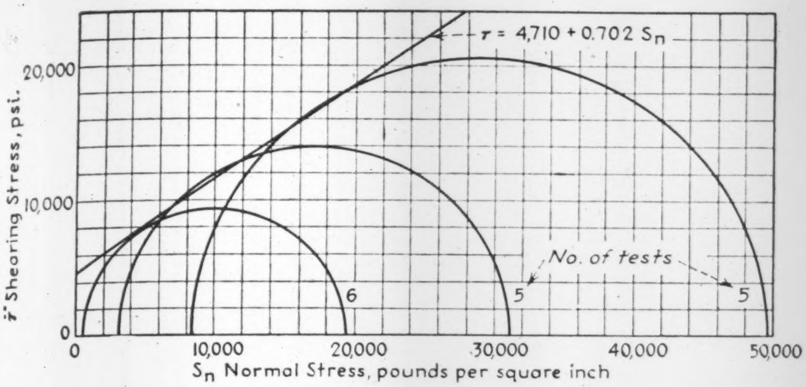

Fig. 4. Mohr's diagram for rock cores from Boulder Dam, used in determining shearing resistance from triaxial tests.

sired, it may be eliminated by extrapolation of the test data.

Mohr's method of determining shearing resistance from triaxial tests is illustrated by Fig. 4. Sixteen drill cores from the foundation rock of Boulder Dam were tested, while encased in rubber jackets, under lateral pressures ranging from 0 to 10,000 psi., with corresponding axial loads varying from 14,900 to 52,400 psi. From these tests three semicircles of the Mohr diagram were constructed, each semicircle representing the average results of five or six tests. These semicircles are drawn so that their two intersections on the horizontal axis represent the lateral and axial pressures under which failure occurred.

Following Coulomb's internal friction theory, the straight line which represents the best approximation to a common tangent to the three semicircles is then drawn and extended to intersect the vertical axis. The equation of this line is found to be $\tau = 4.710 + 0.702S_n$, where τ represents the shearing resistance and S_n represents the normal stress acting on the plane of failure, both expressed in pounds per square inch.

It will be noted from the diagram that a straight line, which accords with the Coulomb theory, provides a reasonably good fit to the three circles, but that a better fit would result from using a slightly curved line. In other words, throughout the range covered by these tests, the increase in shearing resistance is approximately, but not exactly, proportional to the increase in normal stress.

Proposed research

Numerous special problems are scheduled for investigation as time and the development of specialized measuring equipment permit. The weakening effect of pore pressure will be studied by saturating specimens under sustained fluid pressure, and then testing them under various loading conditions. Specimens containing cracks, joints, or seams will be tested both dry and in the presence of fluid pressure. Petrographic and X-ray studies will be made of modifications in crystalline structure under the action of high pressures, and of the effect of microstructures on the failure of crystalline materials under combined stresses.

It is probable that means for applying tension and torsion loads will be added later, and the field of usefulness of the machine, particularly in respect to current problems in metallurgy, will thus be extended.

Housing Under FPHA Control Increased by 150 Percent

In the three-year period since the organization of the Federal Public Housing Authority, the number of dwelling units under the authority's management, development or custody has increased by half a million. The number has grown from 322,000 to 820,000, an increase of approximately 150 percent, according to a recent progress report by the FPHA. The increase has centered primarily in the units under management, which rose from less than 200,000 to more than 700,000, while units under development declined from 129,000 to 35,000. In addition to the units under development or management, the current workload includes about 50,000 completed or partially completed units under custody, a category which did not exist in February, 1942.

An interesting feature of the increased management workload is that the FPHA has had to assume the task of managing much of the public housing program developed in the past three years. This necessity, of course, has arisen from the lack of local housing authorities in areas where much war housing has been placed. In February, 1942, only 36,000 dwellings were under direct FPHA management, but by February, 1945, there had been more than a seven-fold increase to more than a quarter million units under direct management. In the same period the number of units under local housing authority management tripled, increasing from 152,000 to 465,000.

Both the management and development workloads of the FPHA increased during the authority's first year, but after February, 1943, the development workload turned downward from a peak of 275,000, and by February, 1945, had reached 35,000.

The number of persons living in FPHA war housing projects has more than tripled in the period from January, 1943, to January, 1945. On the basis of the average size of tenant families, it is estimated that FPHA now provides war housing for some 1,700,000 individuals.

Ninety-three percent of all available family dwellings in active war housing projects are now occupied; occupancy has increased steadily since October, 1943, when it was 83 percent. Dormitory projects show a decline to 55 percent at the end of May, 1944, then an increase in occupancy, chiefly as a result of deprogramming, to 70 percent the last of February, 1945. After minor fluctuations, the occupancy of stop-gap projects had improved to 73 percent by February, 1945, the highest percentage reached since April, 1943.

Coral—A Good Aggregate in Concrete

J. R. Perry,
Commodore, Civil Engineer Corps, U. S. Navy

Contents in Brief *— How the use of coral helped turn the tide of battle in the Pacific is explained in this article by the officer in charge of a Seabee brigade. He describes the characteristics and relative merits of many different kinds of coral which, surprisingly, make quite good concrete aggregate. Our forces had to build advanced bases speedily on islands where the only material available was coral. What was learned is here recorded with a view to usefulness in postwar Pacific development.*

CORAL HAS PLAYED so important a part in our operations in the Pacific that it might well be acclaimed "our Pacific lifesaver." Despite early doubts as to its usefulness, it has turned out to be a really good construction material, even for concrete aggregate, once those who work with it recognize and understand the various types. It is hoped that the following endeavor to record experience in handling coral will be useful to those who direct further work in the Pacific with this ubiquitous material.

No one gave coral any serious consideration until the defense program got under way. When war made it evident that there would be unprecedented need for aggregate in the Pacific, the concrete laboratory of the 14th Naval District set to work to find suitable materials. Coral deserved first and most careful consideration because it forms or is found along the shores of so many islands of the Pacific. Several thousand species of coral, presenting many different shapes, are found anywhere from considerable depths below low tide to locations in hills and cliffs high above sea level. Useful deposits are found throughout this wide range in form and elevation.

General data on coral

Most forms of coral are somewhat porous, and some are as soft and spongy as volcanic pumice. The form particularly useful as aggregate is that occurring in reefs and ledges, much like limestone.

The interstices in coral are almost microscopic. They are the minute stellately partitioned holes in which the polyp once lived. It lived only on the exposed outer surfaces and hence perhaps 99 percent of the bulk of the coral mass is inner interior skeleton. The condition is perhaps better understood when it is remembered that this animal lives *inside* his skeleton and is constantly secreting material that builds vast coral structures from the inside out, ultimately forming great reefs and ledges. At least 90 percent of the substance of coral is calcium carbonate.

"Live" and "dead" coral

Unfortunately, the terms "live" and "dead" coral have been used extensively by construction forces in the Pacific. These terms do not refer to the presence or absence of animal life. They were coined, rather, to suit a rough classification of coral with respect to its usefulness for construction purposes. The term "live" is applied to coral found either in the sea or in other deposits where it has retained its adhesive qualities. "Dead" coral, on the other hand, is intended to designate coral that has been so dried out by long exposure to air and sun or has otherwise been so changed in form that it no longer retains the ability to bond and set readily. It would be better if these two classifications were described by the terms "fresh" and "dry."

Rate of oxidation

It is to be noted that a layer not more than $\frac{1}{16}$ in. thick of exposed coral surface will oxidize and deteriorate with age. Under most conditions this deterioration is only skin deep. Witness well compacted deposits many thousand years old that are still clean and firm beneath a very thin film. On the other hand, with coral that has been broken up into small fragments, particularly where it is occasionally churned up so that new faces are exposed, the

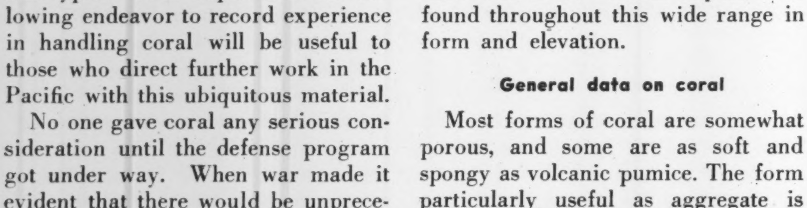

Fig. 1. Bank-run coral with too much fines. Concrete made with this aggregate will be too much like grout, will shrink and crack. This sample, which has passed a 1½-in. screen, has 81 percent fines.

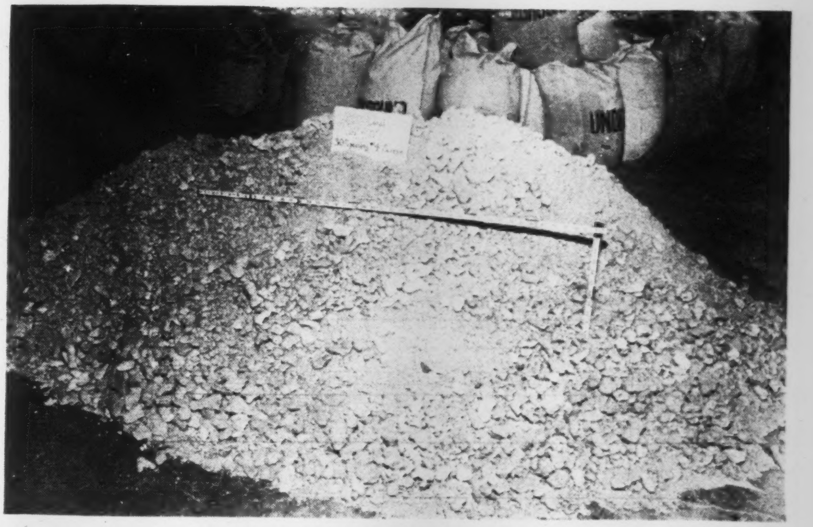

Fig. 2. Bank-run coral with not enough fines to fill the voids. Concrete made with this will have much honeycomb, will be hard to place, harsh and permeable. This sample, which has passed a 1½-in. screen, has 30 percent fines.

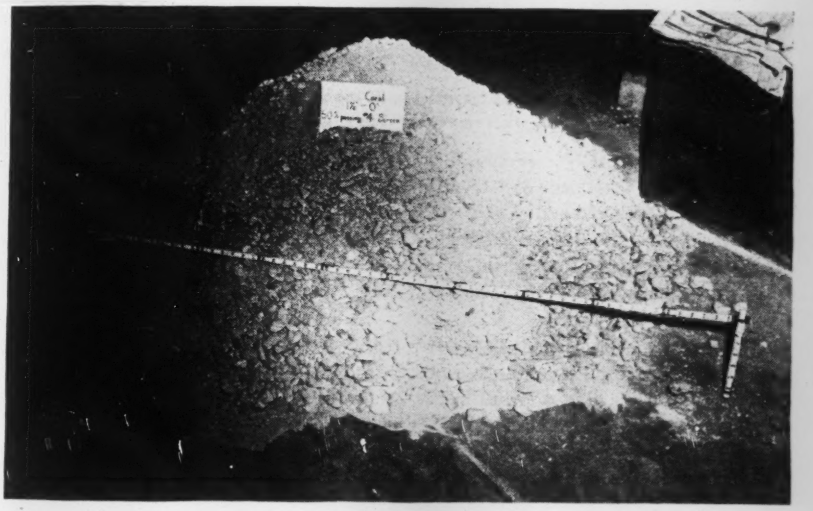

Fig. 3. Bank-run coral with proportions just right for good, plastic concrete. This sample, which has passed a 1½-in. screen, has 50 percent fines.

oxidation perhaps slightly affects the quality and value of the coral as a building material.

Many factors affect the formation of coral and hence the conditions under which the deposits are found. Some of these are water temperature, degree of salinity, amount of suspended matter in the water, water pressure (depth limitations), sunlight, food supply (plankton) and the primary need for a firm bottom to which the original growth of coral may attach itself. Fresh water and solids in suspension account for the usual absence of coral growth at the mouths of large streams discharging into the ocean.

Considerable data on the use of coral in constructing Pacific advance bases and a discussion of "Characteristics of Coral Deposits," by Harold T. Stearns, U. S. Geological Survey, was published in *ENR* July 13, 1944, vol. p. 29.

High absorption

As to absorption qualities, good coral will absorb 20 to 28 percent by weight of moisture without expanding into a plastic mass. Unlike many materials, the absorption percentage decreases as the sizes of coral particles are diminished. Explanation of this is in the fact that coral consists of a countless number of microscopic tunnels and chambers. As the pieces are broken up more and more there is corresponding decrease in the percentage of a given volume that is made up of these open spaces. The specific gravity of coral ranges from 2.65 to 1.40. The effects on the concrete mix, the rate of curing and the final results vary greatly depending on this and other characteristics of the material.

In the emergency created by Pearl Harbor it was apparent that great quantities of aggregate would be needed for advance base construction. It was unthinkable that this aggregate could be shipped from the mainland, but on many of the islands the only local material was coral. Now, years afterward, it seems preposterous to think of shipping aggregate from the mainland or from the Hawaiian archipelago to points west. Yet that was seriously considered at one time because of the lack of information about and distrust of coral. Yet the coral deposits on these islands are adequate in quantity and quality and it was necessary only to develop a knowledge of how to use them effectively.

When Seabees landed on a newly captured beachhead, often still under enemy fire, there was little time, equipment or inclination to make laboratory tests of deposits that might be used for aggregate. Moreover, because it is often a practical impossibility for men working near the front to record their findings, in the early days there was little opportunity to correlate data accumulated at widely separated advance bases.

However, even in the emergency of working on a beachhead still under fire, such great improvement in the quality of concrete can be made by the selection of aggregate based on scientific tests that each forward shipment of cement should be accompanied by a nested set of test screens, which take up no more space than a single bag of cement. Under almost any conditions a technician, even with a very crude field kit, within 24 hr. can complete enough tests to make definite recommendations on the relative merit of available coral deposits as concrete aggregate. Selecting and using the best source, which may be adjacent to one that to the untrained eye looks equally good, may result in

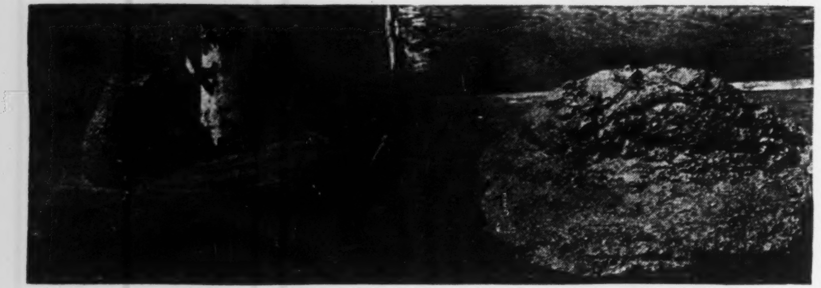

Fig. 4. Concrete made with sample having 81 percent fines. Slump 2¾ in. A 1:4 mix was used for all slump tests.

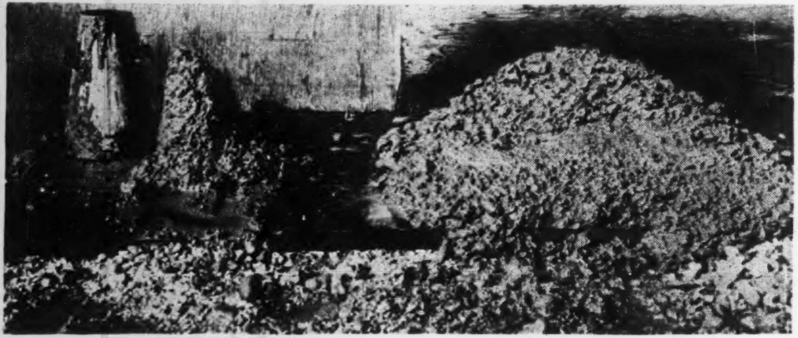

Fig. 5. Concrete made with sample having 30 percent fines. Slump 3 in. Note ravel of slump, tendency of rock to separate. Very unsatisfactory.

increasing the strength of the concrete by 50 percent. Armed with knowledge of the peculiarities of coral as concrete aggregate, an engineer can do an infinitely better job in the field.

Under field conditions the coral that can be expected to make the best concrete will be that containing 50 to 60 percent of fines. The average of one test using 50 percent fines, 9.22 sacks of cement per cu.yd. and 5.28 gal. of water per sack produced concrete that showed compressive strength of 4,250 psi. in 28 days. Under special circumstances coral concrete has been made that would develop more than 5,000 lb. in 28 days. Laboratory tests indicate that 12 to 14 percent more cement will generally bring coral concrete strength up to that made with rock aggregate where both the coral and the rock are sound. This is a rule-of-thumb but useful comparison.

It seems probable that the impossibility of having laboratory control for all concrete construction may account for some of the widely variant opinions about concrete. It is too much to expect that the viewpoint of the design engineer, who habitually works with a calculator and a 9H pencil, will be the same as that of the rough and ready field superintendent working in muddy boots.

Rule-of-thumb concrete

One naval construction battalion living on a barren Pacific island with stoicism and without complaining or shouting for supplies from the rear, used coral as an aggregate for 16 months. The engineering officer reported, "no trouble" with materials he used. When pressed he admitted that certain limitations were imposed by the coarse coral sand which was the only material available as fines. The sand was so coarse that it was difficult to get a finish on the surface of the concrete.

Under these conditions, which are very frequently encountered on coral atolls, the trowel—any trowel—leaves a very rough surface unless a slick of cement is carefully applied over the top. However, the concrete that this battalion made with "no trouble" was very sturdy. There were no serious failures of any kind and no tendency of the concrete to feather or powder with wear.

Garbage incinerators built of concrete by this battalion, despite high temperature and continuous heating and cooling, showed no signs of failure after many months of use. (Later laboratory investigations indicate that coral concrete resists heat somewhat better than concrete made with ordinary aggregates.)

An 8x14-ft. pump house constructed by this same group had a 6-in. concrete roof slab that had to be strong enough to support heavy machinery suspended above a 1,000-gal. sump tank. This building had concrete walls, concrete floors and concrete stairs which sustained considerable wear. At no time was there indication that the job was inferior because coral aggregate was used. This was one of a group of concrete buildings designed for a probable period of service of 2 yr. When last examined the indications were that these structures would be in serviceable condition for at least 5 or 10 yr. without repairs.

Sea water for mixing concrete

On coral atolls there is little if any fresh water and the coral that has to be used as aggregate contains a fairly high salt content anyway. Despite the fact the sea water has long been considered a doubtful ingredient in concrete there was no alternative to using it for mixing water on many important advanced bases.

In looking for literature on sea water in concrete very little was found. The National Bureau of Standards made some tests to determine the effects of calcium chloride as an admixture (*Proceedings*, A.S.T.M., vol. 23, Part II, p. 327) and found that after 5 yr. exposure "corrosion was absent over the greater portion of the surface of the rods, what rust occurred being localized apparently where voids occurred on the surface of the steel. Comparisons of the 1-yr. and 5-yr. specimens indicate that corrosion is not progressive."

The Portland Cement Association reports that concrete mixed with sea water and kept wet for a month or more shows compressive strength lower by 10 to 20 percent than similar concrete mixed with fresh water. "This reduction in strength," the report continues, "is easily corrected by reapportioning the mix, using somewhat less mixing water and somewhat more cement."

The association further points out that sodium and calcium chlorides are not particularly bad for concrete. Up to 2 percent by weight of these salts (percentage relative to neat cement weight) is sometimes recommended as an admixture for hastening setting. Up to 4 percent probably would not be very harmful and ordinary sea water is not believed to greatly exceed 4 percent of these chlorides. The really bad elements, however, are the sulphates and these could be expected to cause immediate damage even when present in quite small quantities. Fortunately these are present in sea water only in very small percentages.

Thus recent experience in the Pacific adds materially to available data on this use of sea water by proving that immediate results, at least, are excellent. Though there has not been enough time to draw definite conclusions as to long time durability of concrete so made, after 2 to 3 yr. service there are no indications of early failure.

Impurities in coral

A man experienced in handling coral can judge its cleanliness by looking at it closely. However, where better control is possible a sodium hydroxide test may be used for determining organic impurities. Under certain circumstances the results of this test are conclusive despite the fact that coral itself is of organic origin. For example, if there are *no* organic impurities present most coral will not show color in this test, thereby indicating cleanliness. Beach sand often contains objectionable amounts of organic matter and the test is particularly important when such sand is to be used in concrete. Some coral sands which look clean will show a dark redish brown test result, when pale amber is the darkest permissible.

On one job where impurities were a menace an aged native saved the day. The problem was to locate a clean sand for use on the bottom of a water purification reservoir. Some beautiful white coral sand was found on a nearby beach. It was such a pleasure to load and handle it that several truckloads had already been dumped into the tank when the native intervened.

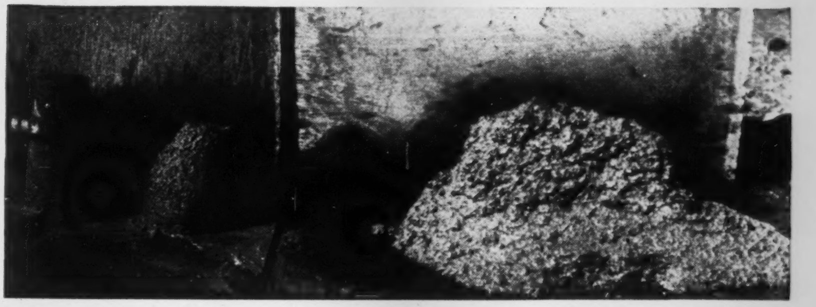

Fig. 6. Concrete made with sample having 50 percent fines. Slump 3¼ in. Quality very good.

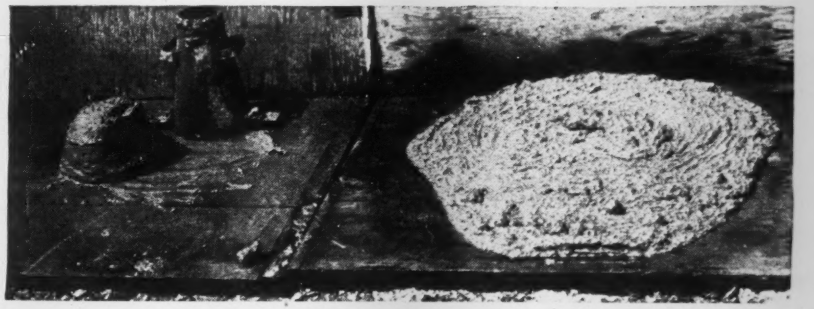

Fig. 7. Concrete made with sample having 81 percent fines. Slump 6 in.

He warned that this sand, from above the high water mark, was full of impurities. He was right: tests showed that the sand had an abnormally high percentage of bacteria. The old man suggested that sand be draglined from the lower beach where it was under water about knee depth. This was done and the water-washed sand was found to be virtually bacteria free.

Local terminology sometimes is found on different islands as the result of practices that have become popular locally. One battalion reported using half coral and half volcanic chips in their concrete. On another island instead of the terms "live" and "dead" coral, the two main types of coral were rated as "bum" and "good."

The "bum" coral broke up easily, was very powdery and dry and contained insufficient lime, clay or other cementing material to make good fill. It could be used for concrete aggregate but did not produce nearly as good concrete as the "good" coral. The latter contained satisfactory amounts of lime and when quarried out of the lagoon, broke up in pieces ranging from small granules up to fragments a yard wide.

Even the "good" coral, however, requires more cement to make concrete as strong as that made with rock. This seems to be a very general observation and is borne out by laboratory tests. The porosity of coral and the rough, dry, powdery texture require more cement paste to lubricate the surfaces and fill the interstices. Although the water-cement ratio remains the same, more water and more cement must be used than would be the case with rock aggregates.

Typical coral characteristics

There seems to be a widespread belief among engineers that measurable strength is added to concrete by the presence of rough, unevenly shaped fragments in the aggregate. These are supposed to "key together," adding strength by fitting against one another snugly and not "slipping and sliding." This is unquestionably true in a fill where smooth stone fragments will never make a job as firm and durable as rough ones.

Are there any conclusive tests to actually prove that the same holds true for concrete aggregate? One laboratory has made tests that seem to explode this old belief. Tests were made on two sets of specimens, similar in composition except as to smoothness of the fragments. The results indicated that the concrete made with smooth aggregates was as strong as that made with the rough fragments.

This is cited because it would ap-

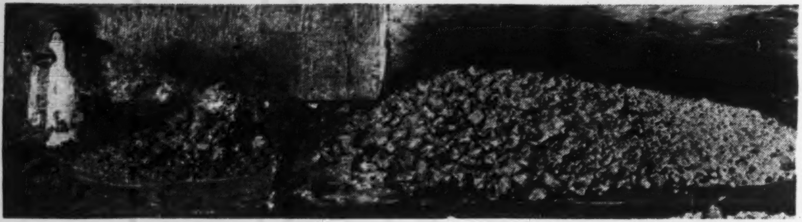

Fig. 8. Concrete made with sample having 30 percent fines. Slump 7 in. Note ravel in the coarse mix.

pear that these findings check with observations on coral concrete. The soundness of the aggregate would seem to be the more important factor in the final strength of the concrete. Obviously soft, crumbly material will weaken the mix but as between two types of equal hardness, one smooth and one rough, there may be actually very little difference in strength once the cement has thoroughly coated the pieces and bonded the whole into a solid mass without voids.

Concrete made with dry, smooth coral sand has a tendency to dry out too fast. In one case, under conditions of tropical humidity, with plenty of moisture in the air at all times, and despite the fact that the concrete was wet down all night long, it still did not cure properly. The trouble was found to be in the high absorption rate of the very old, dry coral. Because of its porosity such coral sucks up water like a sponge, leaving the cement without sufficient water for hydration: the concrete sets too rapidly. The result is lowered strength and usually a tendency to flake, chip and peel. When using very dry coral the best plan is to soak the aggregate or wet it to the point of saturation before combining the ingredients. In other words, use the same theory that is applied by brick masons when they soak brick before applying mortar to it.

Some coral aggregate is of such light weight that it has a tendency to float in the mix. One battalion reported that they had to keep "dunking" the coral to get it to stay down. This so added to the weirdness of the outfit's circumstances that certain hard-bitten concrete men were heard grumbling about it in their sleep!

Generally there is a temptation to make coral concrete too wet for maximum strength. It works easier and makes less honeycomb. However, where light coral is used in a wet mix the coral has more chance to rise to the surface. A stiffer mix sets up more friction and decreases the risk of floating. Again, if the lighter types of coral aggregate are disturbed unduly after pouring and then trowelled repeatedly while the concrete is still fresh, they will be given increased opportunity to rise to the top. These light corals are the soft, porous and powdery type and the result of flotation will be a surface that is impossible to finish smoothly and which will wear very poorly. A good rule with this type of coral is to give the mix maximum stiffness, place it with as little handling as is proper and trowel the surface as late as possible.

Wear on equipment

Construction equipment working with coral on Pacific islands must be able to stand up under very severe working conditions. In addition to corrosive salts in warm, moist air, there is much abrasion and wear from the sharp fragments of shells or other hard formations often embedded in coral. On some coral handling jobs corrosion and attrition have been charged with shortening the life of motor trucks by 70 percent.

Personnel, likewise, has to contend with difficult conditions in working with coral. Because of glare and the occasional cases of "snow blindness," sun glasses are imperative. On some kinds of coral, dust masks are necessary and it is always essential that medical attention be given to any injury no matter how slight if coral or coral dust has been in contact with the skin where a puncture or break occurs. From records of cases where repeated x-rays failed to show the presence of coral fragments later extracted from the patient, it seems possible that coral may have qualities with which it eludes the x-ray.

Selecting coral for aggregate

On advanced base construction it is frequently impossible to determine the specific gravity or the absorption factor of the available aggregate materials, nor can the concrete ingredients be batched by weight. Ac-

TABLE I—COMPRESSIVE STRENGTHS, AFTER 7 AND 28 DAYS, OF BANK-RUN CORAL CONCRETE, MADE WITH VOLUMETRIC MIXES

Fines in aggregate	Class mix	Sacks per yd.	Water cement ratio	Gal. per sack	Slump (inches)	7-day*	28-day*
	1:3	10.43	.351	4.0	3½	3855	3937
	1:3	9.88	.447	5.0	6½	3520	3907
	1:4	8.36	.425	4.8	2-3/4	2910	3440
81%	1:4	8.12	.489	5.5	6	2632	3267
	1:5	6.92	.521	5.88	3½	2244	2799
	1:5	6.78	.574	6.48	6½	2064	2533
	1:6	5.95	.595	6.71	3	1724	2136
	1:6	5.77	.692	7.81	6½	1545	1975
	1:3	8.97	.543	6.12	3	3337	3935
	1:3	8.64	.617	6.96	7	2994	3322
	1:4	7.06	.702	7.92	3	3043	3419
30%	1:4	6.95	.745	8.40	7	2296	2580
	1-5	5.85	.851	9.60	4½	2015	2573
	1:5	5.71	.926	10.45	7½	1724	2049
	1:6	4.98	1.042	11.76	3½	1766	2408
	1:6	4.88	1.085	12.24	7	1300	1510
	1:3	9.22	.468	5.28	3	4152	4250
	1:3	8.88	.543	6.12	7½	3833	4074
	1:4	7.45	.543	6.12	3½	3740	3955
50%	1:4	7.13	.617	6.96	6½	3014	3598
	1:5	6.19	.649	7.31	3	2906	3274
	1:5	6.08	.700	7.90	6	2576	3060
	1:6	4.91	1.010	11.39	2½	2129	2448
	1:6	4.72	1.160	13.09	7	1455	1862

* Figures in two last columns are pounds per square inch and each figure represents the average for three specimens.

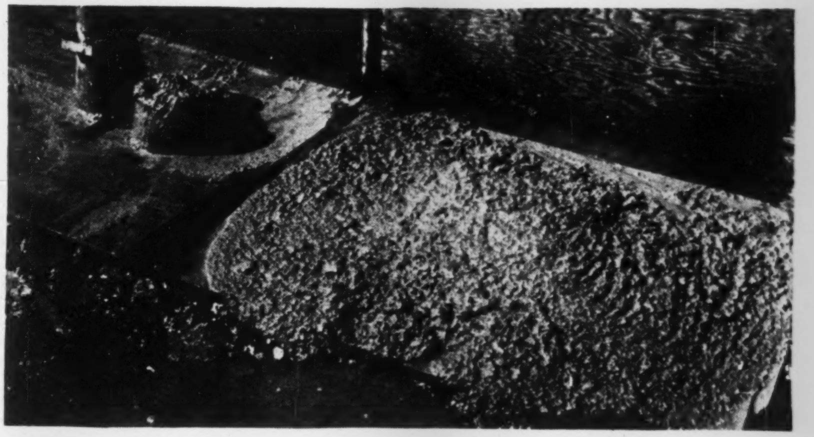

Fig. 9. Concrete made with sample having 50 percent fines. Slump 6½ in.

cordingly, the concrete laboratory of the 14th Naval District* set up a simplified procedure of volume proportioning to do away with the necessity for weighing.

This volumetric method was developed with a view to the fact that dredging operations are rare in forward areas. Hence dredged coral is not included in discussing this method of mixing. Draglines and shovels, on the other hand, usually are found on forward islands. Both produce good aggregate. The action of the bucket breaks up the coral. The proportion of fines produced depends on the kind of coral being dug. With the softer varieties more fines are usually created than would be the case with stone aggregate. However, this is not objectionable because coral aggregate requires a higher than normal percentage of fines.

Two classes of coral

Coral is divided for purposes of this discussion into two main types. Class 1 is the sharp, angular material much like limestone that occurs in reefs and ledges and weighs 70 to 110 lb. per cu.ft., loose volume. Because this coral tends to fracture into large chunks, attrition in trucks and during loading does not necessarily produce a desirable percentage of the very small fragments. However, concrete to meet every practical need can be made with it, including bombproof shelters, by adding fines.

Class 2 is the type widely known as "finger" coral, probably because of its elongated finger-like formation. It is bulbous, light, soft, fragile and porous. It weighs 60 to 80 lb. per cu.ft., loose volume, and makes poor concrete which is hard to work, permeable and will not develop nearly as much strength as that made with the Class 1 aggregate.

On the islands of the Pacific these two types, naturally enough, do not come neatly segregated in bins. The problem is to determine what proportion of a given mixture of the two to use in concrete. This can be done after a thorough understanding has been acquired of the desirable and undesirable attributes of various corals.

The two classes named are by no means sharply defined. If specific gravity were the criterion some finger coral would have to be placed in Class 1. Also, the weight of a particular cubic foot depends on the moisture content and on the amount of fines present. If many fines fill the voids in corals of the coarser types the weight will be greater than the average for the type. If there are few fines the unit weight will be low.

Making concrete with bank-run coral

As distinct from aggregate combinations in which graded materials can be put together, it is frequently necessary to make up concrete aggregates from unclassified or bank-run coral. The first requirement will be a make-shift screen of some sort to remove pieces larger than 3 in. in diameter. Then trial batches must be made up to find whether there are sufficient fines in the aggregate to fill the voids in the coarse material so that honeycombing will not result. Fines, in this case, are particles passing a No. 4 sieve ($\frac{1}{4}$-in. openings).

Figs. 1, 2 and 3 show the appearance of bank-run coral after sizes above $1\frac{1}{2}$ in. were removed. The pile in Fig. 1 has 81 percent fines which is too large a percentage. This makes poor concrete that is too much like grout and is subject to much shrinking and cracking.

The pile in Fig. 2 with 30 percent fines has too low a percentage of fines, not enough to fill all the voids. It makes a very harsh concrete with much honeycomb which is very hard to place and is permeable. The pile in Fig. 3 with 50 percent fines is just the right proportion for a good plastic concrete.

The characteristics of concrete made with generally available coral aggregates are illustrated by the typical mixes, made up in the laboratory, shown in Figs. 4 to 9, inclusive. These are all 1:4 mixes. Note that in each class of concrete two mixes are shown, one with a small slump (Figs.

TABLE II.—RESULTS OF COMPRESSION TESTS ON CORAL CONCRETE AT SEVERAL BASES

Location	Class mix and sacks per yd.	Sp. gr. of coral	28-day compressive strength		Loss by abrasion (percent)
			Natural (graded)	Crushed (graded)	
Island "X"	E-1(6.3)	2.32	3367		13.28
“	F-1(7.5)	2.15	3588	4224	4.90
Island "Y"	D-1(5.4)	2.20	3309		
“	E-1(6.3)	2.20	4194		
“	F-1(7.7)	2.20	4775		8.56
“	F-1(8.0)	2.20	5032		6.34
“	F-1(8.5)	2.20		5915	
Island "Z"	D-1(5.4)	2.19	3486		
“	E-1(6.3)	2.19	4551	4697	12.02
“	F-1(7.5)	2.19	5233	5441	7.24
Finger Coral	D-1(5.2)	1.77	1650		
“ “	E-1(6.0)	1.77	1966		8.46
“ “	F-1(7.0)	1.77	2614		

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* Researches carried out by this laboratory, which are outlined herein, were under the direction of the late Alfred Emmanuel Lindau, eminent concrete engineer.

4, 5 and 6) which is highly desirable and recommended in all cases and one with a large slump (Figs. 7, 8 and 9) which should never be used. The results of the laboratory work on the different materials are listed in Table I.

The piles of concrete on the platform at the right (shown in Figs. 4 to 9) have been dumped slowly from an ordinary wheelbarrow without impact. It will be seen that the height of the pile is about the same as that of the sample made in the slump test. When a slump can is not available the height of a load dumped carefully from a wheelbarrow will give a surprisingly close measurement.

Effect of Overwatering

It is important to note that under no circumstances should more water be used than is needed to make a workable mix. Coral aggregate is far more sensitive to overwatering than normal aggregate and its strength is greatly reduced by just a little too much water. Data in Table I show how effectively the tests emphasize this important point.

Just how much water should be used with each bag of cement is something that must be determined by trial. Since it is assumed that absorption tests are not possible, this determination must be made on the basis of observing the slump. Coral can absorb at least 10 percent more water, by weight, than other aggregates. Often considerably more water than would be expected by mainland engineers must be added. By the same token, coral from out of the lagoon which is saturated with sea water will take a good deal less water than might be anticipated.

A good general check is this: When discharged from the mixer the concrete should form a cone in the wheelbarrow. It should show little surface water. Good concrete will have a slump from 2 to 4 in. For good results any coral deposit with more than 50 percent fines requires the addition of coarse material. Up to 60 percent fines can be used if the cement and water factors are increased in proportion.

Determining the size of particles is difficult, but small tests with made-to-order screens will serve as a good check and percentages of fines can be quite accurately approximated by such sieving of small samples. For practical results in applying data given in Table I the figures should be approximated to the nearest significant decimal.

Some day a crusher may arrive on a forward island, or facilities may be captured and refitted. Then aggregate can be graded and better concrete can be expected. Usually a crusher working on coral will develop sufficient fines to make a balanced grading. Where fines are not available from this source sand can be substituted.

If possible, the material from a crusher should be stockpiled and the fine and coarse aggregate separated. Then a mixture with the proper proportions of each can be made up. If the specific gravity and moisture content of the final aggregate can be determined very high quality concrete can be made. In Table II are given some examples of results attained with methods of graded coral aggregates. These mixes were all batched by weight and were computed in accordance with standard Navy specifications 13Yc.

Coral-cement stabilization

In addition to making good fill and good aggregate, coral is admirably suited to in-place stabilization. In brief, the procedure is as follows: The area to be processed is brought to grade and scarified to a depth of 6 in. Efficient compacting cannot be done at a greater depth. The desired percentage of cement is spread evenly on the surface. Sacks at measured intervals will suffice if a mechanical spreader is not available.

The scarified coral plus cement is thoroughly mixed by disk harrows, heavy duty cultivators, or gang ploughs. If a rotary tiller is available it should be used as it is far and away the most efficient. Enough water is added to bring the mixture to optimum moisture content and for this a pressure distributor, if available, is best. The water is mixed into the coral and cement with the same machinery.

Sheepsfoot rollers which pack the mixture from the bottom up are best as no other device produces comparable density. The required crowning or grading can be done smoothly at this time with a blade grader. Any compaction planes can be removed with a spike-toothed harrow. The top can then be finished off with rollers, either rubber tired or steel, or by loaded trucks. A protective cover of damp coral or other material may be applied to prevent too rapid evaporation.

Careful control needed

Soil stabilization requires careful laboratory investigation before construction can be undertaken safely. Most coral aggregates have little or no organic content and are relatively free from colloids so the risk is not as great as with many soils. Cement contents as low as 6 percent by volume often produce good results. Great numbers of tests with both coral and soil have shown that when the result of laboratory analyses are not available it is a good plan to put in 8 percent by volume of cement as this usually produces excellent stabilization.

Compressive strength tests of 4-in. specimens of coral stabilized with an 8 percent cement content have averaged well over 1,000 psi. and at 14 percent content have averaged 2,000 psi. The tests have shown excellent stability with no volume change during the ASTM wet-dry tests and have fine resistance to abrasion.

It is of the utmost importance that the moisture density relation (ASTM designation D558-40T) be established before any construction is started. Success or failure will depend on proper control. A minimum of equipment is needed for this test. A Proctor mold and rammer, stove or oven for drying samples and a small, but accurate, set of scales (0.05 g. to 100 g.) plus some small containers will suffice. The kit now carried by outgoing Seabee units is equipped with this gear and other items for field testing of materials.

The future of coral concrete

In view of the findings in the laboratory and by battalions on numerous islands of the Pacific, it seems likely that coral as an aggregate in concrete will continue to play a vital role in the conquest of Japan. Whatever the circumstances, Seabees and the other military engineers will find coral handy. They will put it in their foundations, their reservoirs, and their buildings. Who can estimate the total importance of a material so easily found, so widely spread, so useful?

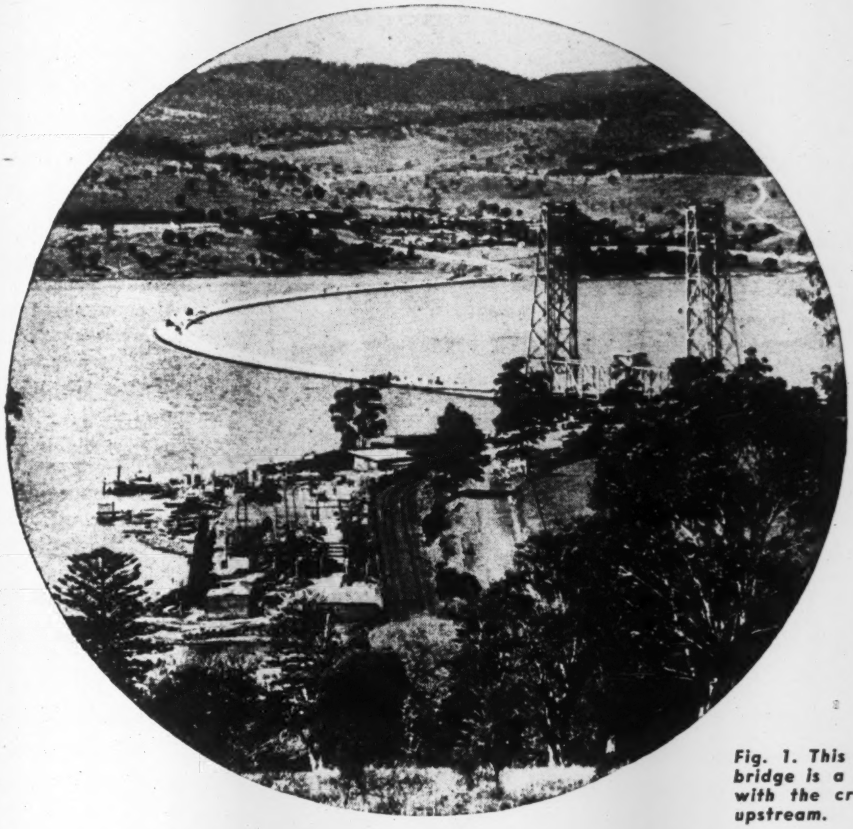


Fig. 1. This floating concrete bridge is a three-hinged arch with the crown of the arch upstream.

Floating Concrete Arch Bridge

***Contents in Brief**—A floating bridge, arched in plan, across the Derwent River at Hobart, Tasmania, is composed of 24 concrete barges each 132 ft. long, between which projecting reinforcing steel was welded to combine two sets of twelve barges each into rigid half-span segments. These two segments with their pin connections form a three-hinged horizontal arch. The arch length is 3,165 ft.; the 40-ft. width provides for a 30-ft. roadway, a 6½-ft. sidewalk and space for a water main.*

SEVERAL NOVEL FEATURES, some without precedent, are embodied in a floating concrete bridge across the Derwent River at Hobart, Tasmania, a part of the Commonwealth of Australia. The bridge, which is twelve miles from the mouth of the stream, was put in service early in 1944 after having weathered a storm so severe as to cause considerable structural damage to the floating arch. The individual units of which the arch is composed are reinforced concrete barges or pontoons, that were cast on shore. However, unlike the floating bridge on Lake Washington, individual pontoon units in the Hobart bridge do not have any cable anchorages. Instead, the units are rigidly connected into two segments, each one-half the total length of the arch. The entire 3,165-ft. length of the floating arch moves freely up and down with variations in water level, which range up to 8 ft. Provision for this variation in roadway height is made by ramps at each abutment.

Each of the two arch segments consist of twelve pontoons each 132 ft. long. The width of 40 ft. includes a 30-ft. roadway, a 6½-ft. sidewalk and space for a water main. Including approaches and a lift span, the total length of the crossing is 4,000 ft.

The arch lies across the river with the crown upstream so that the structure will be in compression the greater part of the time. Thus the abutments take the reactions resulting from water currents acting on the 8½-ft. draft, which is the normally submerged portion of the pontoon cells. The design also took account of the fact that when tides cause the direction of stream flow to reverse, the arch acts like a "horizontal suspension bridge" with resultant tension stresses.

One of the novelties claimed by the patentee in this design is that dead and live loads are carried by the buoyancy of the pontoons, making it different from the ordinary arch design in that only stresses resultant

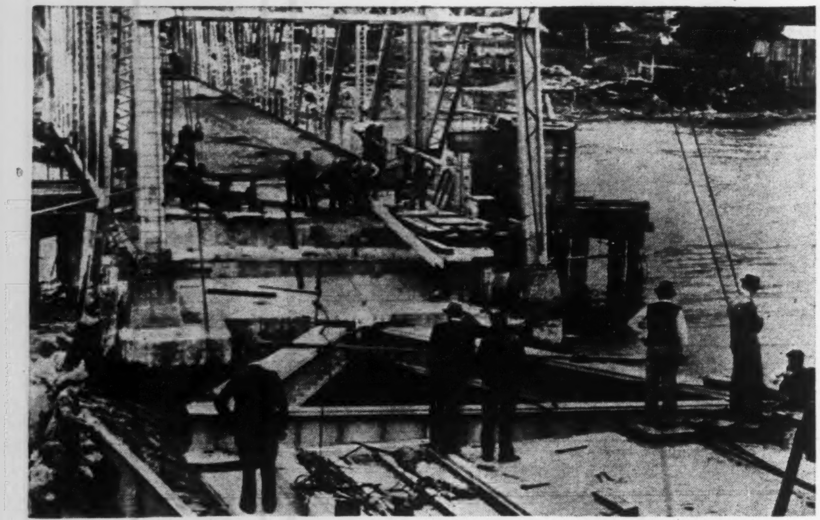


Fig. 2. Provision for an 8-ft. variation in water level is made by ramps at each end over the abutment pin.

from currents and waves are imposed upon the structure. The claim is that such a design makes possible a structure of much lower cost and one that is feasible for much greater span lengths than with the ordinary types of vertical arch or suspension span.

In the construction process, individual units 132 ft. long and 40 ft. wide were cast in the usual manner. They weigh about 1,000 tons each and are separated by partitions into fifteen compartments or cells. After launching, reinforcing steel that had been left projecting from both ends of the units for this purpose was welded together and encased in a protective coating of concrete. When all units had been thus assembled in a pair of twelve-unit groups, each constituting one-half of the arch, they were towed to the site.

Anchors had been sunk at appropriate points for securing a mooring buoy at the approximate center of the span. Using this buoy, the crown ends of the two segments were moored temporarily in midstream. The two segments were then swung around this mooring as a hinge and the pins at the abutments were placed. The pin at the center hinge is 13 in. in diameter.

With abutment pins in place, the gap at the center between the two arch segments was spanned by a steel cable running to the winch of a tractor on one of the segments. With the aid of tugs and other floating equipment the elements of the center hinge were then carefully brought together and the pin at the crown of the arch was put in place in three lugs, two on one segment and one on the other.

Despite waiting for favorable conditions, the center pin was not driven without difficulty. In the exposed location, the effect of wind and current on the long, curved structure made nicety of control a matter of careful maneuvering and coordination.

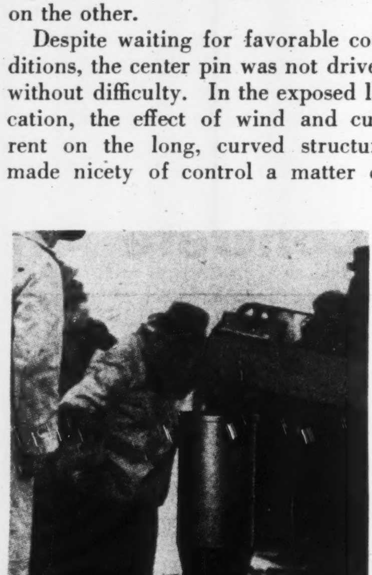


Fig. 3. Two segments of the arch being drawn together prior to placing the steel connecting pin. The pin is 13 in. in diameter and weighs half a ton.

Connecting the floating arch with the fixed abutment is a ramp, the supports of which are shown in Fig. 2. This ramp is supported by six steel girders on a span of 60 ft. The ramp is independent of the triangular system of hinged links which transmit the compression or tension from the arch to the abutments.

Because this bridge crosses a navigable waterway used by ocean-going vessels, it was necessary to provide a movable span. This has been accomplished by a lift span that leaves an open channel 180 ft. wide and a clear height of 150 ft.

The floating arch structure draws 8 ft. 6 in. of water and the level of the roadway is 4½ ft. above water level. A fence 4 ft. 6 in. high with asbestos cement panels protects the roadway from spray that storms blow across the structure.

Bridge damaged by storm

On Dec. 4, 1943, several weeks after the two 12,000-ton segments of the floating arch had been connected in place but before all construction details had been completed, a particularly severe storm swept up the river from the south, building up heavy seas which battered the structure violently. Bolts were broken in the anchorage at the west abutment and transverse cracks appeared in the concrete of the bridge deck at a number of points.

The damage was not severe enough to prevent opening the bridge to traffic and temporary operation was permitted pending completion of repair and certain remedial measures.

Conclusions reached as a result of observing the effect of the storm are summarized as follows:

1. The size of the waves developed in the storm was of the order assumed as a maximum for design purposes.

2. At times the period of the waves corresponded fairly closely with the natural period of vibration of the bridge in a horizontal plane. A considerable amount of resonance occurred particularly in the horizontal oscillations of the bridge.

3. The horizontal oscillation of the bridge which was particularly marked at the ends set up heavy stresses in the triangular steel girders or links anchoring the arch to its abutments.

4. The resonance caused amplitudes and hence resultant stresses that were greater than those assumed in the design. These high stresses were believed to be the cause of transverse cracking of the concrete in the deck of the western half of the structure.

Remedial measures

The parts of the bridge most affected by the storm have since been strengthened. In addition, the public works department states, "A system of prestressing has been installed which increases compressive stresses throughout the structure but reduces tensile stresses." Protective measures are also being taken in the construction of a system of timber breakwaters designed to reduce the size and effect of waves which approach the western end of the structure during southerly storms.

The structure was designed as a toll bridge to make more accessible an area on the suburban side of the river. A. W. Knight, chief engineer, Tasmanian Public Works Department, is the patentee and was in charge of design and construction for the public works department under the direction of G. D. Balsille, director of public works. D. V. Isaacs, Melbourne, was consulting engineer for the public works department and J. A. Slatter, resident engineer.

The project, reported to have cost about $1,100,000, was financed by the Hobart Bridge Co. under a franchise from the Tasmanian government and contract for construction was awarded to Timms Bridge Construction Co. Subsequently the construction work was taken over by the Public Works Department of Tasmania. The bridge was acquired from the Hobart Bridge Co. by the government of Tasmania in December 1944. Compensation payable to the company is to be determined by arbitration.

Demolition of Tall Timber Masts

Lt. Comdr. H. W. Bressler, (CEC) USNR

Public Works Officer, Naval Air Station, Glynco, Ga.

Three timber masts, each 150 ft. high, at the Naval Air Station, Glynco, Ga., were removed without damage to other structures in the area by pulling them over with their own guy lines. The masts were built with four 6x6-in. corner posts with level braces at 10-ft. centers and diagonal braces in every bent. All timber was southern pine of about 1,000-psi. grade. Each tower was guyed with four $\frac{7}{8}$-in. wire rope at 84 ft. above the base and four 1-in. wire rope at 141 ft.

The masts were erected in January 1943 and were painted immediately after erection, chiefly because of the need for obstruction marking on structures of this height in the vicinity of an airfield.

By the fall of 1944, deterioration of some members had progressed to an extent that it was not economical to replace them and removal of the towers was required.

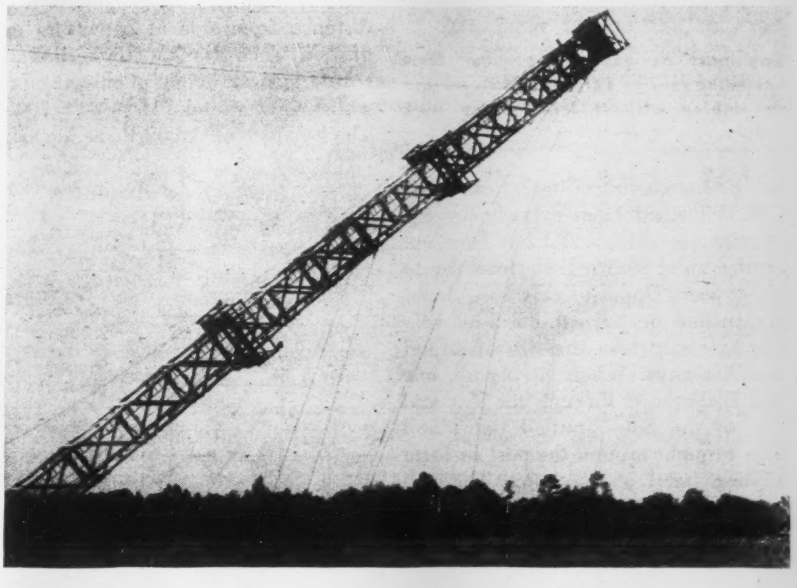
The first method proposed for wrecking the masts included: (7) Tightening the four guys on the "falling" side, (2) disconnecting the four guys on the "far" side, and (3) blasting the corner posts on the falling side. Because of danger of shock to radio equipment in the nearby transmitter building, it was decided to revise the procedure to eliminate blasting. The method by which the masts were dropped included: (1) Tightening the guys on the falling side, removal of all base plate bolts on the far side and all but the lower base plate bolts on the falling side, and (3) disconnecting the guys on the far side.

Mast dropped according to plan

The far side guys were held, after disconnecting, with $\frac{3}{4}$-in. dia. hemp rope. When the ropes on the upper guys were cut with machetes, as the last operation, the weight of the tight guys on the falling side pulled the mast over, with the corner posts on the falling side pivoting about the bolted bases. Each of the masts dropped as planned, with no damage to the adjoining building.

To avoid sending a man aloft to cut one of the antenna from the insecure mast, a porcelain drain insulator was broken with two shots from a Reising gun.

Wrecking of the wood masts, and erection of replacement steel masts, was done by the Public Works forces of the U. S. Naval Air Station at Clynco, Ga. Lt. Comdr. H. W. Bressler (CEC) USNR, Public Works Officer, NAS, Glynco, Ga.



One of three 150-ft. high timber masts demolished at the Naval Air Station at Glynco, Ga. Each was pulled over by tightening the guy lines on one side then suddenly releasing the other lines.

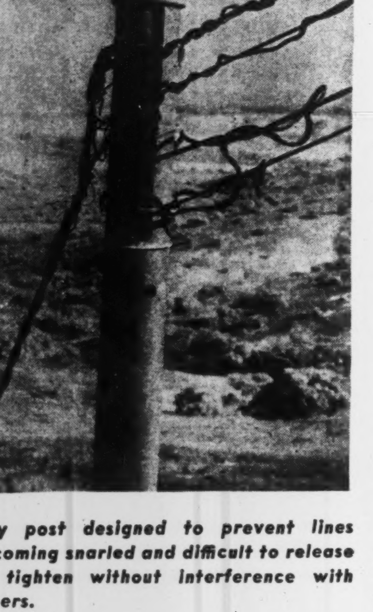
From Field and Office

WORKING PROBLEMS AND TIME-SAVING METHODS FOR ENGINEERS AND CONTRACTOR

Improved Guy Anchor Post

Where more than a single guy line is to be attached at a common anchorage, the lines tend to work toward the top of the post, and to become so snarled that it is difficult to release one guy or tighten it without interfering with the others.

To overcome this problem a contractor designed the post shown in the accompanying illustration. The post is formed from extra-heavy 4½-in. pipe, in which a slot has been cut in the side facing the structure to be guyed. Opposite this slot, holes are drilled or burned on 5-in. centers to easily take the size of strand used for guys. When guying up, one line is threaded through the slot and one of the holes, pulled tight, and then brought around the post to form a close bend at the hole. The end may then be wrapped around the standing part without loss of tension, and with the certainty that the guy will not work up the post and lose tension. Other guys are placed in turn, none interfering with others and always maintaining sufficient working space between wires to insure proper wrapping to secure the ends.



Guy post designed to prevent lines becoming snarled and difficult to release or tighten without interference with others.

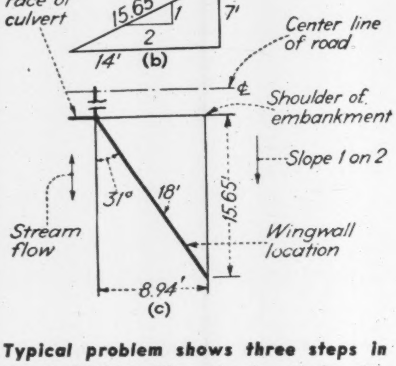
By taking a full turn and a half around the post before wrapping the end, very little of the strain comes on the wrap, and the end need not be seized to prevent untwisting.—CHARLES C. LYNDE, *Houston* 1, *Texas.*

Simple Method of Locating Wingwalls Uses Slope Distance

Location of culvert wingwalls can be quickly and easily determined in the field using the simple method shown in the accompanying diagram. The only original data necessary for the construction are slope and height of the embankment, and the desired height of the wingwall at its end.

In the example shown, the embankment is assumed to be 11 ft. high and to have side slopes of 1 on 2. End height of the windwall is arbitrarily established at 4 ft.

First step is to determine the hypotenuse of triangle (a) for the 4-ft. height and the slope being used. This hypotenuse, 8.94 ft., is the slope distance from side of culvert to end of wall. Then triangle (b) is similarly solved for wall height at culvert minus wall height at end (11 — 4 = 7 ft.). The hypotenuse, 15.65 ft., is the slope distance from shoulder to emban ment to end of wall. Final step is construct (c), using the two prev ously obtained distances as show The diagonal obtained in this ste is the slope distance from corner culvert to end of wall, in this case ft. Angle of the wall can be readil scaled or computed from (c).



Typical problem shows three steps in simple field location of culvert wingalls.

Rapid field layout is accomplishe by turning the angle from the outsid edge of the culvert parallel to its cen ter line and measuring along the slop on this new line the distance obtaine in step (c). The point so located the end of the wingwall.

While the example given here is fo a right-angle culvert, the method ca be used for skew culvert wingwalls a well.—CHARLES H. SYNYARD, *Dept of Public Works, Monroe County Rochester, N. Y.*

"Duck Bills" for Better Tank "Navigation"

The Army has found a partial solutio to the big problem of "navigating" tanks through the deep mud of France. Short lengths of channel steel, called "Duck Bills", are welded to the tan treads as illustrated above. This ide may be used for tractors where diffi-cult terrain is experienced.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Civic Planning

AMERICAN PLANNING AND CIVIC ANNUAL—Edited by Harlean James. 178 pp. American Planning and Civic Assn., 901 Union Trust Bldg., Washington, D. C. $3.

A record of recent civic advance in the fields of planning, parks, housing, neighborhood improvement and conservation of national resources, this tenth annual volume includes the addresses delivered at the Citizens Conference on Planning held during 1944 on the occasion of the 40th anniversary of the organization of the American Civic Association. Civic planning activities in their many phases are discussed from the viewpoint of those interested in national, state and local betterment. Considerable attention is devoted to policy regarding postwar planning and legislation now in effect or needed to implement that policy.

Air Conditioning

AIR CONDITIONING ANALYSIS—William Goodman. 455 pp. The Macmillan Company, New York, N. Y. $6.

The fundamentals of the science of changing the condition of the air are given a comprehensive, unified treatment in "Air Conditioning Analysis." Included are complete psychometric tables for a wide range of barometric pressures. Problems are analyzed by the means of the steady-flow energy equation, which is based on the theory that after steady-flow conditions have been attained, the energy flowing into a given volume must equal the flow of energy out. This method is said to simplify greatly the analysis of various processes.

Heat and Sound Insulation

BUILDING INSULATION—Second Edition, by Paul Dunham Close. 328 pp. American Technical Society, Chicago, Ill. $3.50.

This treatise on the principles and application of heat and sound insulation for buildings attempts to cover the subject in such a manner as to be of practical value to architects, engineers, students, manufacturers, dealers, salesmen and consumers. It includes chapters on methods of application, fundamentals of heat transfer, transmission coefficients, heat loss calculations, effect of building insulation on heating plant size, economics of insulation, condensation, pipe and duct insulation and sound insulation.

Introduction to Engineering

ENGINEERING PREVIEW—By L. E. Grinter, Harry N. Holmes, H. C. Spencer, Rufus Oldenburger, Charles Harris, R. G. Kloeffler and V. M. Faires. 580 pp. The Macmillan Company, New York, N. Y. $4.50.

Intended to serve as an introduction to engineering, the book contains chapters outlining science and engineering, chemistry, technical drawing, mathematics, use of the slide rule, light and electricity, mechanics and thermodynamics, presenting some of the background material needed for the ultimate study of any specialized field of engineering. Quoting from the preface by L. E. Grinter, one of the authors, "It represents the best available technical advice on the subject of what to study and how to study it with the objective of preparation for engineering practice . . . If you find this book tiresome and confusing, it is unlikely that you would want to be a technologist; but if it seems clear and stimulating, you are probably destined to use a slide rule."

Municipal Operations

THE MUNICIPAL YEAR BOOK, 1945—Edited by Clarence E. Ridley and Orin F. Nolting. 603 pp. International City Managers' Association, 1313 East 60 St., Chicago 37, Ill. $8.50.

Among the new features in the volume, in its 12th year of publication, that reflect to some extent the changing emphasis on municipal activities are certain data on municipal personnel administration, planning, and public health. The personnel section contains information on retirement systems for municipal employees, and a brief analysis of state-wide retirement plans for municipal employees. Employment data are more complete this year than formerly. The planning section contains information on zoning ordinances, subdivision control, and extent of regional planning activity. The health section presents up-to-date information on the organization and financing of city-county health units, which are being established in many areas of the country.

A significant new section shows important economic and social characteristics of each city over 10,000 population. Suburbs in metropolitan districts are classified into residential, employing, and balanced communities, and given a rent level classification.

Other new data include official post-1940 populations for some cities, number of suburban municipalities and the number of units of local government in each metropolitan district. A notable section in this edition brings up to date the information on the classes of cities and forms of municipal government which last appeared in the 1938 year book.

Railroads in China

CHINA'S STRUGGLE FOR RAILROAD DEVELOPMENT—By Chang Kia-Ngau. 340 pp. The John Day Co., New York. $5.

This is not a new book as it was published in 1943, but it received little attention in the technical press when it first appeared. Now that invasion of China by American forces appears impending, Mr. Chang's account of the way China developed her railway systems takes on new significance. Although much of the book relates to financial matters, there also are detailed accounts of construction operations, especially those of recent years under the handicap of Japanese occupation of much of the country. This latter information may be of value to our engineers who will have to rehabilitate the railways taken over when invasion comes.

New Engineering Books

TRACK AND TURNOUT ENGINEERING, Third Edition—By C. M. Kurtz. 461 pp. Simmons-Boardman Publishing Corp., New York. $5.

PIPING HANDBOOK, Fourth Edition—By Sabin Crocker. 1376 pp. McGraw-Hill Book Co., New York 18 and London. $7.

BRAWN AND BRAINS, The Adventures of an International Contractor—By Franklin Remington. 217 pp. Bruce Humphries, Inc., Boston. $2.75.

AN INTRODUCTION TO SOIL MECHANICS—By W. L. Lowe-Brown. 57 pp. Sir Issac Pitman & Sons, Ltd., London. 4/6 Net.

WHEN DEMOCRACY BUILDS—By Frank Lloyd Wright. 131 pp. The University of Chicago Press, Chicago. $4.

CONSTRUCTION STEELWORK SIMPLY EXPLAINED, Second Edition—By Oscar Faber. 128 pp. Oxford University Press, London and New York 11. $2.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

(Continued from page 93)

covered with metal lath to form the treads and risers and the vertical wall of the balustrade. The whole was then plastered, on both sides, with a stiff mixture of cement, sand and fine granite chips to a thickness of about two centimeters.

Simpler still, was the procedure if the stairway was located in a well with continuous walls and a fair sized central pilaster. In such cases recesses suitable to receive the ends of flat steel bars were provided in the concrete at such locations that the flat bars, when placed after the wall and pilaster forms had been removed, formed the top and bottom of each riser. After these flat bars were in place they were covered with metal lath, to form treads and risers, and plastered as previously described.

Charles Jay Seibert
6310 Eight St., N.W.
Washington 11, D.C.

Flood Prediction Compared

Sir: In *ENR* June 14, 1945, vol. p. 833, E. J. Gumbel presents an analysis of flood flows by probability methods. The writer does not intend to compare the relative merits of Mr. Gumbel's method and the use of normal probability paper as developed by Allen Hazen. However, the implications that Hazen expected the application of normal probability relationships to flood flows would result in straight lines are refuted by the extensive papers and discussions which have been presented before the American Society of Civil Engineers by Hazen, Foster and others, regarding the use of skew curves.

In fact, Hazen states in his book, "Flood Flows": "The whole subject of flood flow quantities may fairly be said to be a study in skew curves. Data are said to follow a skew curve when they follow or approximate a law of probability but not the normal law."

In Mr. Gumbel's method the plotting position of the largest flood of a series of n terms approaches $1 - \frac{1}{n}$, and for a series of 20 terms, for example, the last term is plotted at very nearly 0.95. In Hazen's method the last of a 20-term series is plotted at 0.975. If we consider only the 20-yr. flood record, there is no question that the maximum flood of the period occurred once in 20 yr. and can be considered the 5 percent chance flood for this particular series. However, we are usually not interested in the 20-yr. record alone, but rather in the extension of such a record to indicate what may be expected over a longer period of time. (A 20-yr. record is too short to be of much value in predicting floods and is used here merely for simplicity.)

For example, consider the 20-yr. record extended to the 1 percent chance flood corresponding to the maximum flood in 100 yr. If Mr. Gumbel's 20-yr. curve extended represents properly the series to be expected in 100 yr., there would be four other large floods as great or greater than the maximum flood in the 20-yr. record. These would correspond with the approximate plotting positions of 0.96, 0.97, 0.98 and 0.99. Plotting the terms according to Hazen's method has the effect of placing the maximum flood during the 20-yr. period in the middle of the five largest floods to be expected in 100 yr. In Hazen's method the plotting position for the last 5 terms in a 100-term series are 0.955, 0.965, 0.975, 0.985 and 0.995.

We do not know whether the maximum flood in a 20-yr. record is greater or smaller than the flood to be normally expected to occur on an average of once in 20 yr. over a much longer period of time. Sometimes a probability plot of a fairly long record will give some indication one way or the other, but no general rule can be stated. Mr. Gumbel's plotting will yield greater estimated floods and is therefore conservative, but there is no indication that the results are more accurate than those obtained by the other procedure.

The data for the Mississippi River at Vicksburg have been analyzed by the methods described in "Flood Flows". The results are compared with those obtained by extending Mr. Gumbel's curve as follows:

	Million cfs	
	Hazen	*Gumbel*
2% chance flood	2.19	2.34
1% " "	2.36	2.34
0.1% " "	2.87	3.25

Richard Hazen
Lieut. (CEC) USNR
Bureau of Yards and Docks
Norfolk 10, Va.

Composite Rigid Frames

Sir: The article, "Rigid-Frame Concrete Span Requires No Falsework," by Jacob Feld (*ENR* May 3, 1945, vol. p. 625), prompts me to draw your attention to the fact that a similar scheme was designed by the Ontario Department of Highways before the war. These, however, were for much longer spans (maximum 120′0″ clear), and were designed on the so-called "box girder" principle with ribs at 9 ft. 0½ in. center to center.

The fabricated reinforcing was to be supported at the center of the span for 21 days. Sections and elevations are illustrated in *Roads and Bridges*, Feb., 1942, pages 27 and 31.

Unfortunately, because of the war, these structures were not built. However, the steel, which had been fabricated, was stored on the site and we hope that conditions will soon permit their completion.

V. S. Murray
Ontario Dept. of Hwys.
Toronto, Ontario, Canada

Paul Thompson's Career

Sir: In your writeup of Brig. Gen. Paul W. Thompson, (*ENR* July 12, vol. p. 20), I fail to find mention of General Thompson's tour of duty at the Waterways Experiment Station as its director, which commenced July 1937 upon his return from Germany, and continued until September 1939 when he was called to Washington. His previous connection with the Waterways Experiment Station as assistant to the director covered the period June 1932 to October 1933.

Gerard H. Matthes
Head Engineer
Director, U. S. Waterways Experiment Station, Vicksburg, Miss.

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

HIGHWAYS, OREGON

OWNER: Oregon State Highway Dept., Salem, Ore.

PROJECT: Bridge construction, furnishing gravel, grading, and bituminous macadam surfacing 4.36 miles of the Coyote Creek-Graves Creek section of Pacific Highway, Josephine County, Ore. Involves construction of two concrete bridges, four concrete box culverts, two timber bridges, furnishing gravel in stockpiles, in addition to highway surfacing.

CONDITIONS: Contractor to furnish all materials. Highway transportation available to site. Wage rates specified are: skilled labor $1.20 per hour; semi-skilled, 75 to 90c.; and common, 62½c.

BIDS: Twelve bids were received May 15, 1945, ranging from the contract low of $601,501 to $984,637.

LIST OF BIDDERS:

1. McNutt Brothers, Eugene, Ore. (contract)	$601,501
2. G. F. Atkinson, San Francisco, Calif.	662,230
3. K. L. Goulter, Seattle, Wash.	664,865
4. Larson Bros. & Harms Bros., Sacramento, Calif.	678,264
5. E. C. Hall Co., Portland, Ore.	692,404
6. Kuckenberg Constr. Co., Portland, Ore.	728,657
7. E. B. Bishop, Orland, Calif.	771,784
8. Leonard & Slate Oregon, Ltd., Portland, Ore.	772,185
9. Guerin Bros., San Francisco, Calif.	805,489
10. Peter Kiewit Sons Co., Omaha, Nebr.	820,065
11. Morrison-Knudsen Co., Boise, Idaho	887,516
12. E. J. Eldon, Portland, Ore.	984,637

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clearing and cleaning-up	70 ac.	$335.00	$350.00	$250.00
2. Grubbing	30 ac.	335.00	150.00	250.00
3. Extra clearing	19 ac.	350.00	250.00	300.00
4. Extra grubbing	3 ac.	350.00	200.00	300.00
5. Felling dangerous trees	200 s. f.	1.00	4.00	3.00
6. Shoring, cribbing, etc	Lump Sum	2,100.00	10,000.00	1,600.00
7. Structural excavation	540 c. y.	4.00	4.00	6.00
8. Struct. excavation, below specified elevations	50 c. y.	4.00	10.00	13.00
9. Trench excavation, unclassified	3,200 c. y.	2.00	2.25	2.00
10. General excav., Locations "A", unclassified	590,000 c. y.	.30	.40	.38
11. General excav., Sta. 326 to 332+60, unclassified	100,000 c. y.	.35	.46	.38
12. Gen. excav., Sta. 342 to 344, unclassified	25,000 c. y.	.35	.40	.38
13. As above, Sta. 356 to 373	100,000 c. y.	.35	.45	.38
14. As above, Sta. 412 to 446+60	48,000 c. y.	.30	.39	.38
15. Short overhaul	2,700,000 st. yd.	.01	.004	.01
16. Long overhaul	74,000 st. yd.	.28	.25	.40
17. Rounding cutbanks	15,000 l. f.	.10	.10	.15
18. Finishing roadbed and slopes	4.36 mi.	500.00	250.00	1,000.00
19. 9-in. perf. corr. metal pipe	1,800 l. f.	2.00	1.35	1.10
20. 6-in. perf. concrete pipe	1,200 l. f.	.53	.50	.60
21. 10-in. perf. concrete pipe	2,100 l. f.	.92	.90	1.10
21. 12-in. perf. concrete pipe	660 l. f.	1.17	1.10	1.50
22. 18-in. concrete pipe	1,120 l. f.	2.27	2.40	2.70
23. 24-in. concrete pipe	1,300 l. f.	3.35	3.30	4.00
24. 30-in. concrete pipe	290 l. f.	5.43	5.50	6.50
25. 18-in. extra str. conc. pipe	330 l. f.	2.50	2.80	3.30
26. 24-in. extra str. conc. pipe	420 l. f.	3.66	4.00	4.60
27. 30-in. extra str. conc. pipe	220 l. f.	6.00	6.00	7.00
28. Std. conc. catch basin	1 ea.	50.00	250.00	200.00
29. Spec. concrete catch basins	1 ea.	50.00	250.00	250.00
30. Gravel backfill in drains	1,300 c. y.	3.00	2.90	4.00
31. Wood sight posts	170 ea.	4.00	4.50	4.00
32. Class A conc. in slab, bridge and box culverts	510 c. y.	46.50	40.00	40.00
33. Cl. A conc. in Grave Creek bridge	740 c. y.	43.00	42.50	43.00
34. Metal reinforcement	214,000 lb.	.0625	.06	.0775
35. Metal handrail	620 l. f.	9.00	5.75	6.75
36. Detour bridge	Lump Sum	7,500.00	11,500.00	6,800.00
37. Untreated lumber, in place	2.5 M bm.	125.00	160.00	140.00
38. 2"–0" gravel in base	14,500 c. y.	2.00	2.00	2.25
39. ¾"–0" gravel in base and shoulders	13,000 c. y.	2.50	2.30	2.70
40. Add'l. ¾"–0" gravel in key course	4,000 c. y.	3.00	2.50	2.40
41. Filler	200 c. y.	.50	.75	.35
42. Hauling filler	400 y. mi.	.10	.20	.12
43. Sprinkling	1,300 M gal.	2.00	2.50	1.50
44. Preparation of base	4.36 mi.	150.00	200.00	200.00
45. Furn. and place aggregates	7,300 c. y.	3.50	3.10	3.40
46. Furn. and place 120–150 pen. asphalt	450 ton	28.50	24.00	27.00
47. Furn. and place RC-3 or emulsified asphalt	70 ton	28.50	28.00	27.00
48. ¾"–½" cr. gravel in stockpile	600 c. y.	3.00	1.75	2.10
49. ½"–¼" cr. gravel in stockpile	600 c. y.	3.00	2.00	2.10
50. ¼"–0" cr. gravel in stockpile	200 c. y.	3.00	2.50	2.10
51. Hauling crushed gravel (pile meas.)	3,500 y. mi.	.10	.15	.12

OUTFALL SEWER, CALIFORNIA

OWNER: City of South San Francisco, Calif.; Charles T Broughton, works engineer.

PROJECT: Construction of outfall sewer, pump house, and force main in connection with South San Francisco, Calif sanitary sewer project. Sewer discharges into deep water of bay and the work involves furnishing and placing 24-in., 27-in., 36-in., 42-in., and 48-in. diameter sewer pipe; sewage pumps and equipment; jacking corrugated steel casing under the Bayshore Highway; pile bents; concrete manholes, etc.

CONDITIONS: Contractor to furnish all materials and complete work in 180 days. Highway transportation facilities available to project site. Wage rates stipulated are: skilled labor, $1.50 per hour; semi-skilled, $1.2125; and common 95c. Alternates were allowed for three types of pipe for force main: 24-in. reinforced concrete; 27-in. Hume process concrete pipe; 30-in. Hume process concrete pipe; 24-in., 27-in., or 30-in. wood stave pipe. Also alternate bids were asked on the corrugated steel casing, either 42-in. or 48-in All bid prices are shown below, but the totals shown are for 24-in. reinforced concrete pipe and the 42-in. casing.

BIDS: Two bids were received June 4, 1945, the low of $130,439 and $135,529.

LIST OF BIDDERS:

1. McGuire & Hester, Oakland, Calif. (low bidder)	$130,439
2. Peter Sorenson, Redwood City, Calif.	135,529

Item	Quan.	Unit Prices (1)	(2)
1. Vitr. clay pipe sanitary sewer, 24-in.	2,168 l. f.	$9.50	$8.00
2. Conc. manholes, complete with cast iron frames and covers, incl. 2 drop manholes	8 ea.	320.00	200.00
3. Crushed rock support for sewer	1,000 ton	2.00	5.00
4. Vitr. clay pipe sewer, 27-in	1,737 l. f.	10.00	10.00
5. Vitr. clay pipe sewer, 36-in.	100 l. f.	13.75	12.00
6. 24-in. rein. conc. pipe force main	4,540 l. f.	8.00	11.00
7. 18-in. rein. conc. pipe force main, incl. 24x18-in. wye branch and two 18-in. tide gates	275 l. f.	8.50	9.00
8. 42-in. corr. steel casing jacked under Bayshore Highway	60 l. f.	75.00	100.00
9. 30-in. conc. pipe sewer with 30-in. tide gate	150 l. f.	10.00	15.00
10. Pile bents, complete	10 ea.	175.00	250.00
11. Control manhole, complete	1 ea.	1,250.00	350.00
12. Construct roadway to pumping plant, and fill pumping plant site	Lump Sum	3,750.00	2,000.00
13. Excavation for pump house and screen chamber	Lump Sum	8,000.00	800.00
14. Construction of Cl. A concrete pump house and screen	180 c. y.	82.50	45.00
15. Sewage pumps, motors, electrical equipment, automatic bar screen, piping valves, fittings, control apparatus, wiring, lighting and incidental work to complete and equip pump house ready for operation	Lump Sum	11,500.00	18,000.00
16. Fencing pumping plant site, incl. 12-ft. gate (400 l. f.)	Lump Sum	780.00	600.00

Alternate Items

Item	Quan.	(1)	(2)
6a. 27-in. Hume process conc. pipe in place of Item 6 above	4,540 l. f.	8.85	11.00
6b. 30-in. Hume process conc. pipe in place of Item 6 above	4,540 l. f.	9.50	12.00
6c. 24-in. wood stave pipe in place of Item 6 above	4,540 l. f.	8.50	11.00
6d. 27-in. wood stave pipe in place of Item 6 above	4,540 l. f.	9.50	12.00
6e. 30-in. wood stave pipe in place of Item 6 above	4,540 l. f.	10.50	13.00
8a. 48-in. corr. steel casing jacked under Bayshore Highway in place of 42-in. casing in Item 8 above	60 l.f.	80.00	110.00

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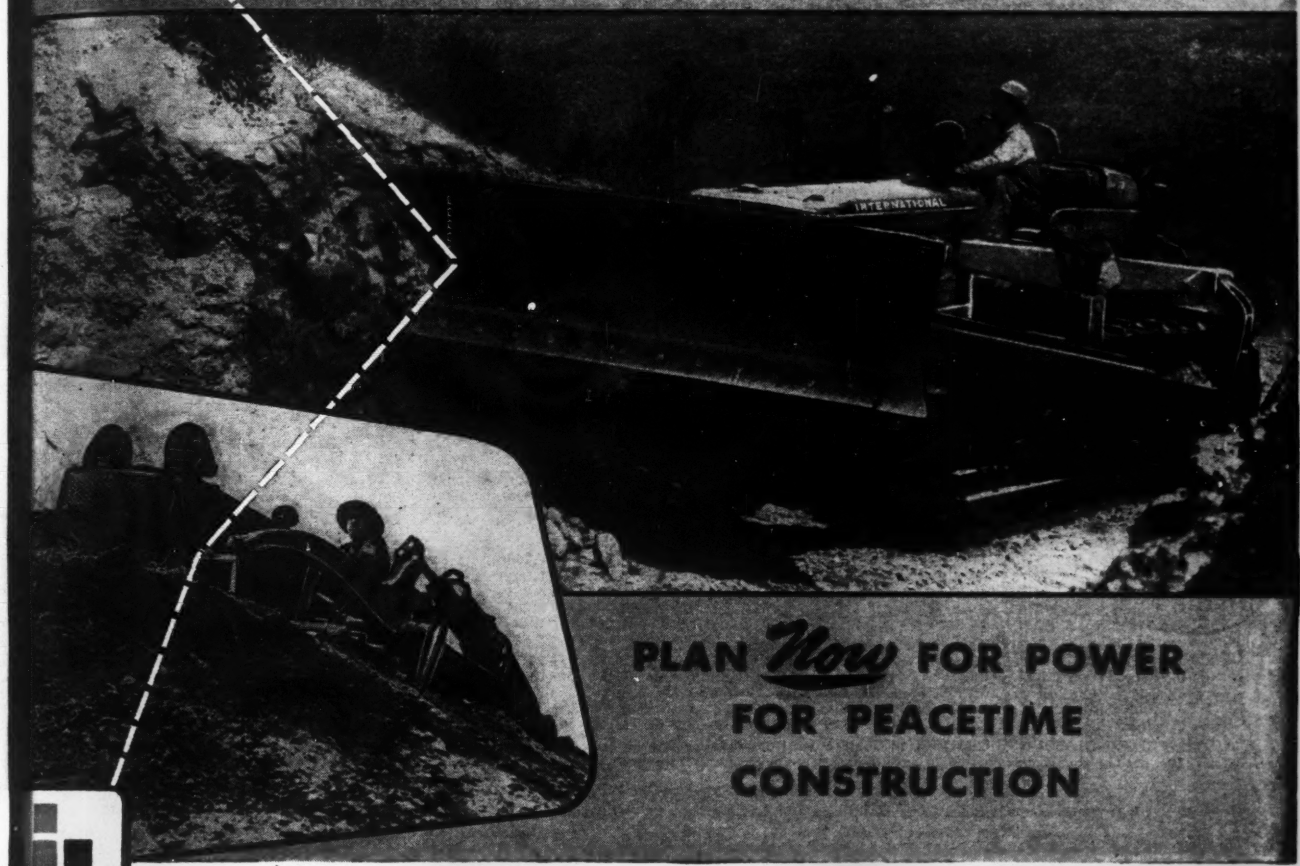

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INTERNATIONAL POWER

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

CONSTRUCTION MATERIAL prices and labor rates reported to *Engineering News-Record* for August record the following changes from a month ago: Portland cement in cloth is up 24c. per barrel in Denver; ready-mixed concrete is up 75c. per cubic yard in New York, but off 15c. in Cleveland; structural steel shapes declined 7.1c. per 100-lb. in New Orleans.

Southern pine is $1.00 to $4.50 higher on 1- and 2-in. boards in Atlanta, but $1.00 lower on 3x12-in. boards. In Chicago 1-in. pine boards are $1.00 higher, and 2x4-in. boards are up $3.50 per M ft., b.m. Montreal fir prices were substantially increa but fir prices are $1.00 to $5.00 lower in New Orleans.

Structural clay tile is up in Denver but has declined in Montreal. Common br climbed in Cleveland and Denver, but is down $1.64 per M in Montreal.

Carpenters' rates rose 7½c. per hour in Chicago and Kansas City, and structu ironworkers' rate climbed the same amount in the latter city. Hoisting engineers' a plasterers' rates in Chicago are 10c. and 2½c. higher, respectively, than last mon

CEMENT, AGGREGATE, READY-MIXED CONCRETE—F. O. B. CITY

	PORTLAND CEMENT Per bbl., C/L lots, incl. 40c. per bbl. for bags, cash dis. not deducted			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plan		CONCRETE BLOCK 8x8x16-in.: truckload del.; per block		CONCRET Ready Mi 1:2:4, ove 50 c.y., de
	Cloth *a*	Paper	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in	¾ in.	1½ in.	¾ in.	Sand-grav.	Lt.wgt Agg	
Atlanta	$2.77	$2.52	$2.47	$1.79	$1.89	$1.99	$1.79	$1.89	$1.59	$1.69	$0.17	....	$8.30
Baltimore	2.62	2.37	2.12	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.75‡	1.75‡	.125	$0.125*w*	7.45
Birmingham	2.50	2.25	2.10	1.75	1.75	1.50	.85	1.00	.90	1.15	.1425	....	5.80
Boston	2.97*b*	2.72*b*	2.52*b*	1.50‡	1.50‡	1.05‡	1.25‡	1.35‡	....	....	.13	.155*w*	7.55
Chicago	2.90	2.65	2.50	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.75‡	1.75‡	.18	.18*x*	...
Cincinnati	2.41	2.16	1.96	1.20	1.20	1.10	1.80	1.80	....	....	.12	.15*w*	6.70
Cleveland	2.49	2.24	....	1.75*i*	1.75*i*	1.25/1.65*i*	1.80*i*	1.80*i*	1.15	1.15	.14	.14	7.30
Dallas	2.51	2.26	2.06	1.50*p*	1.70*p*	1.10*p*	1.69*p*	1.79*p*	....	....	.15	....	7.15
Denver	3.32	2.72	2.47	1.20	1.30	1.25	1.65	1.75	1.00	1.00	.15	....	7.25
Detroit	2.49	2.24	2.09	1.50	1.50	1.30	2.25	2.25	2.00‡	2.00‡	.13	.14*w*	7.15
Kansas City	2.58	2.33	2.18	1.85	2.30	1.00	1.91	1.91	....	....	.125	.125*wy*	7.50
Los Angeles	3.20*v*	2.60*v*	....	1.30	1.30	1.15	1.30*f*	1.30*f*	....	....	.04*bb*	.10*aa*	7.25
Minneapolis	3.07	2.82	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	.14	....	7.55
Montreal	....	1.95*rs*	1.79*rs*	1.65‡*s*	1.65‡*s*	1.50*t*	.80*ct*	.90*ct*	....	....	.14*t*	.14*w*	7.85
New Orleans	2.41	2.16	1.92	1.67	1.65	1.22	....	....	.90	1.15	.19	....	9.25
New York	2.85‡	2.60‡	....	1.60*de*	1.60*de*	.90*de*	1.70*de*	1.80*de*	....	....	.16	.14*wcc*	8.25
Philadelphia	2.73	2.48	2.28	1.55‡	1.65‡	1.20‡	1.90	1.95	1.10	1.10	.155	.155*w*	8.45
Pittsburgh	2.70	2.45	2.25	1.65‡	1.65‡	1.85‡	2.25‡	2.25‡	1.50	1.50	.17	.17*z*	8.40
St. Louis	3.00	2.72	....	1.75‡	1.40‡	1.25/1.40‡	1.25*h*	1.25*h*	.90*g*	1.10*g*	.145	.13*w*	8.60
San Francisco	2.21	2.01	1.71	1.36	1.36	1.36	1.46	1.46	....	....	....	.21*y*	7.55
Seattle	....*u*	3.00*o*	....	2.35*d*‡	2.35*d*‡	2.35*d*‡	2.85‡*od*	2.85‡*od*	....	....	.16	.16*y*	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* F.o.b. quarry. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount of 2 percent for cash in 10 days. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 d *r* 10c. per bbl. off, cash 20 days. *s* 8% sales tax included. *t* 8% sales not included. *u* Withdrawn. *v* 20c. per bbl. discount; 20c. allowed for retu able cloth bag. *w* Cinder. *x* Waylite. *y* Haydite. *z* Celocr *aa* Pumice. *bb* 4 x 8 x 12 in. *cc* Also 8 x 18 x 18 in.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash disco 10c. per bbl for payment within 15 days of date of invoice. Subject discount 10c. per bbl 20 days in Montreal.

CURRENT MAXIMUM PRICE BASES AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refunda

	Bagged	Bulk		Bagged	Bulk		Bagged
Buffington, Ind	$1.90	$1.85	Ironton, Ohio	$1.70	$1.65	Richard City, Tenn	$1.80
Dallas, Tex	....	....	Limedale, Ind	....	....	Steelton, Minn	2.00
Hannibal, Mo	1.90	1.85	Norfolk, Va	....	....	Universal, Pa	1.75
Hudson, N. Y	....	....	Northampton, Pa	1.75	1.70	Waco, Tex. (Plus 9c. tax in Tex.)	1.75
Independence, Kans	1.70	1.65	North Birmingham, Ala	....	....	Montreal City (8% sales tax incl.) Discount 10c per bbl 20 days	1.68

PAVING BRICK, BLOCK, ASPHALT, ROAD OILS—F. O. B. CITY

	PAVING BRICK AND BLOCK			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS—FLUXES Per gal., 80–300 penetration		CUTBACK ASPHALT Per ton		ROAD OIL Per gal	ASPHALT EMULSION (Quick-breaking) Per gal
	Granite per M lot of 50,000 4x4x8 in	Brick per M 3x4x8½ in carload lots	Wood per sq. 6d 3½ in 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car
Atlanta	$73.00	$39.35	$2.25	$18.53*e*	.....†	$0.0740*e*	......†	$0.0806*he*	.......†	$0.0781*e*	$0.0806
Baltimore	150.00‡	49.00	85.00*m*	15.00*r*	21.00*r*	.06*r*	.09*r*	13.00*r*	23.00*r*	.06*r*	.07*r*
Birmingham	150.00	32.00*j*	.....	17.95	.....†	.0747	......†	.0834*h*	.......†	.065	.095
Boston	85.00	59.00	3.75	15.00	24.00	.0625	.115	17.00	30.00	.0625	.0825
Chicago	150.00	55.00	2.50/2.80*d*	14.00	22.50	13.00*g*	21.50*g*	.0575*h*	.15*h*	.05*n*	.09/.10*n*
Cincinnati	120.00	53.75	.....	17.00	.....	.085	......	12.25	....	.07	.085
Cleveland	120.00	30.00	3.50*l*	17.00	19.00	.085	.095	.10*h*	.11	.08	.10
Dallas	......	36.00	.....	13.65	20.30	.06	.11	16.00	24.80	.06	.05/.07
Denver	......	16.11	.....	11.00	.....	10.00	......	.045*h*	....	....	....
Detroit	......	37.00	.....	18.06*f*	25.60*f*	.0734	.128	.0718*h*	.119*h*	.067	.0775
Kansas City	......	30.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11
Los Angeles	......	50.00	.....	9.00*b*	23.00	9.50*bg*	24.00*bg*	9.50*b*	....	.025	.072
Minneapolis	......	.....	2.30*d*	.....	27.70	.....	.126	....	32.64	....	....
Montreal	92.40	.....	.....	16.60*k*	24.25*k*	.116*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.135*k*
New Orleans	......	.....	.....	13.50*a*	20.00*a*	.057	.088	.06*h*	.095*h*	....	.080
New York	......	65.00	.....	17.40	24.20*p*	14.00	......	.0725*h*	.1325*hp*	....	.0725*p*
Philadelphia	140.00	58.00	4.06	15.00*r*	.....	14.00/15.00	......	.0625*h*	....	....	14.00*gr*
Pittsburgh	135.00	39.75	.....	18.00	23.00	.09	.16	20.00	36.00	.07	.06
St. Louis	......	39.00	.....	16.00	22.00	15.00*g*	21.00*g*	.0575*h*	.12125*h*	.648	.06
San Francisco	......	45.00	.....	10.90	21.15	10.90*g*	18.00*gr*	12.90	17.50*r*	9.50*gr*	.0525
Seattle	......	.....	.....	10.90*i*	21.90*i*	....	20.40*gi*	11.40*i*	....	....	.0525*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 12-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3½x8½ in *k* Tax included *l* F.o.b. *m* Per thousand † Available on priority only and quoted specially. *p* No drum shipments except to armed forces. *r* February 1943 prices, none available.

In war or peace
B.F.Goodrich
FIRST IN RUBBER

New tire with built-in shock shield has greater bruise resistance, lasts longer

THE TIRES you see here are taking what might be grueling punish- ent for some kinds of tires. They're ing used in airport construction, rying heaped loads, 55 each shift, a 1.8-mile road trip haul. Rocks and s can't always be avoided, and every e a tire "hits" them it's a pile-driver w—the kind of impact that could se bruises and blow-outs. Such nishment often leads to expensive pairs, delays, or costly replacements.

But these B.F.Goodrich tires are ll protected against such losses by a cial *shock shield* built in under the ad. This shield, developed by F.Goodrich engineers, is a set of *four* eakers—layers of rubber-coated yon cords—between the tread and e plies. The breakers are in *pairs,* with the cords in each pair running parallel to each other—but with each pair running in opposite directions to give balanced strength. The breakers are cushioned with thick layers of special shock-resistant rubber.

Under impact, the cords in the breakers stretch together, *not* across each other, and return to their original position. The blow is *distributed* and *absorbed* by the rubber cushions; the shock passed on to the cord body is greatly reduced.

Proof that users of B.F.Goodrich off-the-road tires benefit by this exclusive construction principle is shown in their own service records. One strip mine operator reports an average of over 4000 hours of service from BFG tires compared to 1600 hours from another make; another operator reports 17,599 miles compared to 6476 for the best ordinary brand.

You can make worth-while savings—and you can *see* the savings in your own records of comparison tests of B.F.Goodrich tires alongside other makes.

Supplies are limited, but tentative orders are being accepted now. For best delivery, see the local B.F.Goodrich dealer or write us direct. *The B.F.Goodrich Company, Akron, Ohio.*

Truck Tires BY
B.F. Goodrich

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ⅝-in. billet *b*	RIVETS ¾-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.75	$2.90	.....	$43.00	$45.00	$45.00*	$2.70	$3.25	$2.30	$4.75
Chicago	2.10	2.15	3.75	2.90	$2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Pittsburgh	2.10	2.15	3.75	2.90	2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	....	....	2.30	....
Cleveland	2.10	2.15	3.75	2.90	.....	.....	.....	.....	....	....	....	....
Youngstown	....	2.15	.....	.....	.....	.....	.....	.....	....	3.25	....	....
Detroit	....	2.27‡	.....	.....	.....	.....	.....	.....	....	....	....	....
Gulf ports	2.47*a*	2.52*a*	.....	.....	2.85*a*	.....	.....	.....	....	....	....	....
Pacific ports	2.75*a*	2.80*a*	.....	3.40	2.95*a*	.....	.....	.....	....	....	....	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per cl
* Per net ton.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LBS., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb base price	REINFORCING BARS* Per 100 lb., ⅝ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots Std. diamond mesh, 3.4 lb	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 sq ft., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No 6 & 6 wires *k* Per 100 s. f	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.40	$2.40	$.02½	$.10	$21.06	$23.00	$1.82	$1.35	$1.91	$3.04
Baltimore	3.70	2.90	2.75	....	.10	23.00	25.00	1.70	1.27	1.79	3.00
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.00	21.00	1.80	1.34	1.89	....
Boston	3.912	3.994	....	$20 C.L.	.10	18.50	29.50	1.76	1.31	1.84	2.77
Chicago	2.10*a*	2.15*a*	2.15*a*	.03	.05	21.50	23.50	1.67	1.25	1.75	2.40
Cincinnati	3.68	2.53*cd*	2.53*cd*	....	.05	19.50	21.50	1.66	1.25	1.74	....
Cleveland	3.588*k*	3.10*k*	3.10*k*	.02½	.10	19.50	21.50	1.66	1.25	1.74	....
Dallas	4.25	3.17	3.17	....	....	25.50	27.50	1.93	1.42	2.03	....
Denver	4.57	3.33*k*	....	....	....	26.50	26.50	1.97	1.45	2.07	....
Detroit	3.661‡	2.50‡	2.50‡	....	.10	30.00	30.00	1.68	1.26	1.76	2.66
Kansas City	4.19	2.61*cd*	2.61*cd*	.0	.05	24.50	26.50	1.78	1.33	1.87	2.874
Los Angeles	3.65*f*	2.575	2.425	.02½	.05	23.00	27.50	1.93	1.42	2.03	3.65
Minneapolis	3.81‡	2.73	2.73	.0	.10	25.00	27.00	1.80	1.34	1.89	2.73*d*
Montreal	3.95*i*	2.90*i*	2.80*i*	....	....	31.00*hi*	46.00*hi*	2.76	3.44*i*	2.82*im*	....
New Orleans	4.158‡*k*	3.59*k*	....	.05	.10	23.50	22.00	1.82	1.35	1.91	2.875
New York	3.75	2.76*e*	2.76*e*	....	.15	17.50	19.50	1.76	1.32	1.81	2.74
Philadelphia	3.666	3.668	....	....	....	20.50	22.50	1.71	1.28	1.79	2.72
Pittsburgh	2.10*a*	2.15*a*	2.15*a*	.02½	.10	23.00	26.50	1.59	1.20	1.67	2.40
St. Louis	3.697	2.74	2.74	.0	.05	23.00	34.00	1.69	1.27	1.78	2.70
San Francisco	4.35	2.825	2.675	.02½	.10	21.00	24.50	1.93	1.42	2.03	3.70
Seattle	2.75*e*	2.80*e*	....	....	....	34.50	38.50	1.93	1.42	2.03	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 25c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. difference between new billet and rail steel in many mills. *h* List price. *i* Plus Dominion and Province sales tax. *k* Quotation on changed basis; no actual price change. *m* Per sq. yd

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in. *a*	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	Delivered std. 12 in., s.s	ASTM 24 in.	C13–35 36 in.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in.; Lap Weld Black %	Galv. %
Atlanta	$50.66	$0.31*b*	$0.558*bc*	$3.082*c*	$5.70*e*	$110.00	$140.00	$0.45	$1.70	48.2	54.2	59.7	51.2
Baltimore	54.00	.35	.60	2.70	7.25	160.00	200.00	.65	1.90	65.5	57.5	63.0	54.5
Birmingham	46.00	.275	.495	1.95	5.50	100.00	220.00	.50	1.70	62.2	54.2	59.7	51.2
Boston	56.40	.371*r*	.7155*r*	2.79*r*	7.6875*r*	170.00‡*r*	265.00‡*r*	.60	1.95	....	....	....	....
Chicago	55.33	.35	.675	2.70	7.00	100.00‡	150.00‡	.45	1.85	66.0	55.0	64.5	53.0
Cincinnati	54.27	.231	.4455	1.80	5.125	105.00‡*s*	170.00‡*s*	.75*t*	1.75*t*	57.1	43.4	54.0	39.6
Cleveland	55.75	.231*r*	.4455	2.025	5.25	90.60	139.40	.36	1.47	68.5	57.5	66.0	54.5
Dallas	57.43	.31	.58	2.25	5.00	90.00	110.00	.46	1.57	....	....	....	....
Denver	62.56	.32‡	.576‡	2.376‡		95.00‡	2.6400†	1.00†	2.00†	58.4	50.4	55.7	47.2
Detroit	55.75	.385	.7425	2.925	7.75	170.00‡*u*	263.00‡*u*	.36	1.75	57.6	44.0	54.5	40.2
Kansas City	56.73	.35	.59	2.20	6.20	160.00	300.00	.45	1.60	35.6	46.1	46.2	59.4
Los Angeles	69.40	.325†	.585†	2.70†	6.75†	130.50	217.50	1.00	2.00	61.1	50.1	58.6	47.1
Minneapolis	60.10	.305†	.549†	2.196†	6.25†	......	......	.90	2.10	64.2	53.2	60.7	49.2
Montreal	67.00	.85*o*	1.50*o*	5.25*p*	8.50*ep*	45.00*m*	64.00*m*	.48*m*†	1.92*m*†	....	....	....	....
New Orleans	52.78	.37*r*	.78	1.69	......	150.00	220.00	.45	1.65	62.4	54.4	58.8	50.3
New York	53.40	.336	.648	2.835	6.97	......	......	.60	1.40	64.9	53.9	62.4	50.9
Philadelphia	52.00	.35	.675	2.75	7.50	165.00	225.00	.45	1.75	56.6	42.8	53.6	39.1
Pittsburgh	57.00	.266†	.513†	2.295†	5.945	97.80	154.20	.85*g*	2.00*g*	68.5*i*	57.5*i*	66.0*i*	54.5*i*
St. Louis	55.62	.31	.504	2.016	4.50	90.80	220.00	1.00*j*	2.15*k*	56.4	42.6	52.5	38.4
San Francisco	69.40	.3625*d*	.6525*d*	2.61	6.52	115.00	192.50	.58	2.34	45.0	31.0	41.0	26.0
Seattle	71.20	.40	.72	2.88		115.20	......	.51*l*	1.44*l*	....	....	....	....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $50.00 Based on existing freight rates; subject to rate change. Gas pipe and class A. $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.; ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92; 3 per cent tax on transportation costs not included. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base Butt-weld—1 in. and 1¼ in black 34, galv. 16; 1½ in. black 38, galv 18½ 2 in. black 37½, galv. 18. Lapweld—2½ in. to 3½ in black 31½ gal. 14½ 4½ in. to 8 in. black, 32½ galv. 17 Reinforced; spec C 76–37. *k* Reinforced; spec. C 75–37. *l* Plus sales tax. *m* Tax included *n* 27-in pipe *o* Less 50% *p* Less 53%. *s* Price quotations on delivered basis since Mar. 1940; current f.o.b. price $84 for 6 in.; $130 for 8 in. *t* Reinforced pipe prices since May, 1937; current plain pipe prices are: 12 in., 36c.; 24 in. $1.50 *u* Scarce carload quantities not readily available

LUMBER, TIMBER PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

SHORT LEAF YELLOW PINE AND DOUGLAS FIR: **All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)** *All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*

LONG LEAF Y. P.: Merchantable grade up to 20 ft.

PLYWOOD: Rail freight increment (See note for base price)

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.		PLYWOOD	
	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	2x12 Rgh	12x12 Rgh	5/8"	3/4"
Atlanta	**$41.00**	**$41.00**	**$35.50**	**$38.50**	**$37.50**	**$41.50**	**$45.00**	......	......	$60.50	$64.00	$17.90	$21.85
Baltimore	**44.00**	**46.00**	**44.00**	**46.00**	**47.00**	**52.00**	**65.00**	......	......	115.00	120.00	18.25	22.25
	48.00	*49.00*	*55.00*	*55.00*	*55.00*	*57.50*	*68.00*	*$75.00*	*$75.00*	......	......	......	......
Birmingham	**45.00**	**45.00**	**44.50**	**43.50**	**44.50**	**47.50**	**68.00**	**55.00**	**56.00**	......	......	17.35	21.15
^{1}	50.00	50.00	49.50	48.50	49.50	52.50	72.00	......	......	67.50	70.00	......	......
Boston	60.00^3	60.00^3	60.00^3	60.00^2	60.00^2	62.00^3	66.00^3	......	......	58.00^3	58.00	18.25	22.25
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*54.00*	*58.00*	*58.00*	*58.00*	......	......	......	......
Chicago	**55.00**	**55.00**	**58.50**	**54.00**	**54.00**	**60.00**	**68.00**	......	......	80.00*l*	95.00*l*	14.60	17.80
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*55.00*	*56.00*	*56.00*	*57.00*	......	......	......	.....
Cincinnati	**47.50**	**49.00**	**42.50**	**42.50**	**42.50**	**44.50**	**67.00**	......	......	65.00	65.00	17.35	21.15
	......	......	......	......	......	......	......	......	......	......	......	......	.....
Cleveland	**42.50*k***	**42.50*k***	**52.50*k***	**51.00*k***	**65.00**	**65.00**	**83.00**	**83.00**	**83.00**	......	......	17.75	21.60
Dallas *e*	**45.25**	**45.25**	**44.50**	**43.00**	**43.00**	**47.25**	**60.75**	**58.75**	**58.75**	88.75	85.00	14.60	17.80
Denver ‡	68.00^4	68.00^4	64.75^4	65.25^4	63.75^4	64.75^4	68.75^4	*72.00*	*72.25*	......	......	10.45	12.70
Detroit	**61.00**	**61.00**	**57.75**	**57.75**	**57.75**	**63.75**	**71.00**	......	.....	70.75	90.00	17.35	21.15
	57.00	*57.00*	*57.00*	*57.00*	*62.75*	*72.75*	*75.00*	*75.00*	*90.00*	......	......	......	......
Kansas City *a*	**69.00**	**69.00**	**67.00**	**65.50**	**67.00**	**69.00**	**84.00**	......	......	84.00	94.00	12.60	15.40
	66.00	*66.00*	*59.50*	*59.50*	*59.50*	*59.50*	*75.00*	*80.00*	*80.00*	......	.....	......	......
Los Angeles *a*	*60.00*	*60.00*	*60.50*	*60.75*	*59.25*	*59.25*	*72.75*	*72.00*	*72.00*	......	......	9.90*gh*	12.05*gh*
Minneapolis ‡*b*	62.00^8	61.00^8	......	......	......	......	......	......	......	......	......	12.60	15.40
‡	*69.00*	*69.00*	*60.00*	*61.00*	*59.00*	*60.00*	*61.00*	*65.00*	*65.00*	......	......	......	......
Montreal †^{7}	*64.00*	*65.00*	*60.00*	*63.00*	*65.00*	*70.00*	......	......	......	200.00	200.00	......	......
	90.00	*90.00*	*90.00*	*90.00*	*90.00*	*90.00*	*80.00*	*80.00*	*80.00*	......	......	......	......
New Orleans	**41.00**	**39.50**	**37.00**	**35.00**	**34.00**	**36.00**	**46.00**	......	......	55.00	69.00	14.60	17.80
	30.50	*30.50*	*30.00*	*30.00*	*29.00*	*29.00*	*28.50*	*29.50*	*29.50*	......	......	......	......
New York	**67.50**	**67.50**	**62.50**	**62.50**	**62.50**	**64.00**	**74.00**	......	......	120.00*f*	125.00*f*	18.35	22.25
‡	......	......	*65.00i*	*65.00i*	*65.00i*	*65.00i*	[Range from $75 to $95]			......	......	......	......
Philadelphia	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	......	......	130.00	130.00	18.25	22.25
	75.00	*75.00*	*75.00*	*75.00*	*75.00*	*75.00*	*85.00*	*90.00*	*90.00*	......	......	......	......
Pittsburgh	**50.80**	**53.20**	**62.75**	**55.00**	**60.85**	**62.50**	**76.25**	......	......	......	......	18.10	22.05
	69.20	*68.10*	*66.10*	*65.30*	*65.20*	*65.65*	*82.75* •	*88.75*	*88.75*	......	......	......	......
St. Louis ‡*c*	**61.00**	**61.00**	**57.00**	**56.00**	**57.00**	**59.00**	**71.00**	*75.00*	*75.00*	87.00	87.00	14.60	17.80
San Francisco *d*	*41.00*	*41.00*	*36.50*	*36.75*	*35.75*	*35.75*	*37.50*	*36.00*	*36.00*	......	......	7.30*g*	8.90*g*
Seattle	*51.25*	*51.25*	*45.75*	*45.75*	*44.50*	*44.50*	*47.00*	*47.75*	*46.50*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* F.o.b. cars San Francisco freight rate. *e* 10% discount taken off. *f* Up to 18 ft. † Plus sales tax.

Note: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $95.15; on 3/4", $104.85; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *i* Ranges from $65 to $75. *j* Average price. *k* August 1943 price. *l* September price; none later available.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	 B quality	EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	74%	75%	$0.15
Baltimore	78%	79%	.15
Birmingham	76%	76%	.105
Boston	77%	78%	.15
Chicago	77%	77%	.15
Cincinnati	77–10%	77–10%	.15
Cleveland	77%	77%	.19
Dallas	76%	76%	.1625
Denver	76%	76%	.155*e*
Detroit	77%	77%	.1575
Kansas City	77–10%	77–10%	.155
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	77%	77%	.155
Montreal	40–10–2%*ab*	50–2%*ac*	.1675†
New Orleans	70%	75%	.16
New York	81%	82%	.22*f*
Philadelphia	78%	79%	.15
Pittsburgh	79%	79%	.1225
St. Louis	77–10%	77–10%	.155
San Francisco	66%	73%	.155
Seattle	75%	75%	.1575†

Price of 60% Ammonia Gelatin in $0.01 per lb. higher than 40%

a Discount from list Sept. 1939; sales tax included, but 6% tax exemption not allowed for. **b Single thickness.** *c* Double thickness. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal St. add delivery charge of $6.00 per trip. [1] F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me.	$0.105	$0.13	$0.15
W. of Miss. to Rocky Mtn. States, Fla. and Maine.	.11 –.1175	.135 –.1475	.155 –.1675
Rocky Mtn. States	.11 –.1225	.135 –.1525‡	.155 –.1725‡
Pacific N. W. States	.1075–.12	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1125	.135 –.1425	.155 –.1625

‡ F.o.b. Louviers, Colo., or Butte, Mont.

PILES TIES— F.O.B.

PILES

Prices per linear foot, fir and pine, bark on, f.o.b. cars, New York. Fir based on Wash. and Ore. points to New York shipping area; pine based on freight from Norfolk.

Dimensions	Points	Length	By Rail Pine*	 Fir
12-in. at butt	6-in.	30 to 50-ft.	$0.34	......
12 in.— 2 ft. from butt	6-in.	50 to 59-ft.	.35	......
12-in.— 2 ft. from butt	6-in.	60 to 69-ft.	.36	......
12-in.— 2 ft. from butt	6-in.	90 to 100-ft.	....	.5575
13-in.— 3-ft. from butt	5-in.	91 to 100-ft.	....	.5608
14-in.— 2-ft. from butt	6-in.	50 to 69-ft.	.41	.6175
14-in.— 2-ft. from butt	6-in.	70 to 79-ft.	.43	.59
14-in.— 2-ft. from butt	5-in.	80 to 85-ft.	.54	......
14-in.— 2-ft. from butt	5-in.	85 to 89-ft.	.57	......
14-in.— 2-ft. from butt	5-in.	90 to 100-ft.	....	.60

* Pine piling over 80-ft. available only in limited quantities.

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8′ Untr.	 Tr.	7"x9"x8′6" Untr.	 Tr.
Boston	Oak	$1.50	....	$2.00	....
	Pine	2.00	$3.00*a*	2.50	$3.00*a*
New York	S. L. Sap Pine	1.43/1.54	2.59	1.76	2.86
	Mixed Oak	1.71	2.59	2.42	3.58
Birmingham	White Oak	1.00	1.60*a*	....	2.25*a*
Chicago	Red Oak	....	2.00/2.25*a*	....	2.87/3.00
Los Angeles	Douglas Fir	2.00	3.25*a*	2.90	4.70*a*
Philadelphia	Red Oak	....	2.10*ag*	....	3.25*ag*
St. Louis	White Oak	1.63	....	2.19	....
	Red Oak	1.63	~~2.20*a*~~	2.19	3.04*a*
	Sap Pine or Cypress	1.70	....	2.06	....
San Francisco	Douglas Fir	1.25*bef*	....	....	3.00*eaf*
Montreal	Birch or Maple	....	....	....†	....†

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6"x8"x8′6". *c* Empty cell. *d* Zinc. *e* Green. *f* F.o.b. cars † Out of market. *g* January 1943 price, none later available.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	**$2.50– 3.10**
Chlorine cylinders, liquid, per lb., delivered	**.0525**
Calcium chloride, 77–80%, flaked, 100-lb. paper bag, del'd, ton.	**18.50–35.00**
Silicate of soda, 52 deg. in drums, f.o.b. works, per 100 lb	**1.40**
Soda ash, 58%, in paper bags, per 100 lb. dense	**1.15**
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	**23.00–25.00**
Sulphate of copper, in bbl., per 100-lb	**5.00**

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE PARTITION — SCORED Per M lots of 2,000 pieces or over, 3x12x12 in.			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M lots of 2,000 pieces or over, 8x12x12 in.			BRICK Per M in quantity Common backing		LIME Per ton, Hydrated finishing		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized, or lump
Atlanta	$104.00	$114.00	$199.00	$234.00	$244.00	$250.00	$18.25	$20.04	$26.54	$15.04	$15.04
Baltimore	84.00	90.00	170.00	200.00	260.00	300.00	17.00*k*	21.00*k*	19.00	14.00	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	16.50	23.00	18.11	13.64	2.25*lo*
Boston	103.75*a*	110.65*a*	207.45*a*	248.90	......	......	20.00*i*	20.00*i*	21.00†	......	16.00
Chicago	79.50	85.00	160.00	197.00	243.00	278.00	15.00	16.00	17.00	15.00	12.50
Cincinnati	65.55	69.90	131.20	148.70	210.35	240.45	25.75	25.75	15.50	13.00	......
Cleveland	82.50	97.35	182.50	......	......	......	20.75	20.00	18.80	16.80	......
Dallas	71.40	76.40	145.30	183.50	238.00	294.50	15.25*i*	16.75*i*	19.00	15.00	15.00
Denver	91.20	102.60	165.30	189.80	238.00	262.00	19.50	18.00	25.00*j*	17.00*j*	20.00*j*
Detroit	92.70	96.70	174.50	198.80	257.20	294.30	20.50	20.50	18.00	16.00	16.00
Kansas City	67.00	69.00	89.00*c*	128.00	163.00	189.00	14.00	16.00	19.32	13.00	10.92
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.50	15.00	16.50	17.50	17.50
Minneapolis	87.00*b*	92.80*b*	157.30*b*	......	189.00*b*	262.00*b*	25.50	27.50*g*	21.00	16.00	19.00
Montreal	92.50*a*	98.50*a*	196.25*a*	151.50*a*	100.50*at*	134.50*av*	22.16†*u*	33.20†*u*	24.60*u*	17.10*u*	20.00*u*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	......	18.30	12.08	14.10
New York	90.80	96.80	133.10*c*	219.80*h*	269.80*h*	333.90*h*	17.50/18.50*x*	......	20.00	14.00	17.00
Philadelphia	104.20	111.20	208.40	250.10	305.10	377.70	18.75	21.75	19.00	16.00	15.00
Pittsburgh	74.20	79.15	148.40	233.00	284.00	325.00	21.25	23.25	17.90	15.40	2.55*m*
St. Louis	67.00	72.00	130.00	190.00	244.00	290.00†	20.50	19.50	22.00	18.00	2.50*m*
San Francisco	96.00	108.00	144.00	108.00*t*	......	......	21.50	......	24.00	23.00	2.50*m*
Seattle	115.00	125.00	230.00	......	......	......	20.50*f*	24.00*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in., 3-cell. *d* Not load bearing. *e* 48 lb. tile. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* F.o.b. Warehouse only. *f* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *r* 5% discount 10 days. *s* 2% discount for cash. *t* 5½x8x12. *u* 8% sales tax included. *v* 6x12x12-in. *w* Per 200 lb. bag. *x* Price withdrawn; May 1945 quotation.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

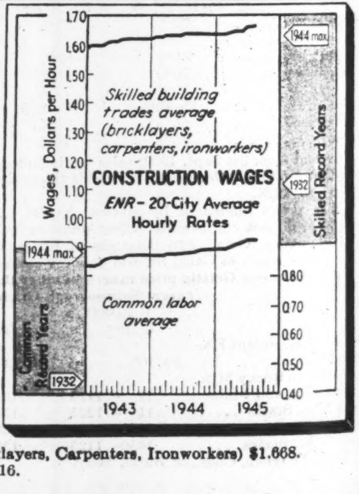
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*			ROOFING SUPPLIES Carload lots f..o.b.. factory Rolls, slate surfaced, 85–90 lb. per sq.				
	Dry *a*	in oil	Graphite *b*	Aluminum *b*	Ferric Oxide *d*	Rolls, slate surfaced, 85–90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$10.25	$14.125	$1.30	$2.25	$1.20	$1.85	$1.72	$1.72	$0.305	$27.00
Baltimore	10.00	13.75	2.00	3.00	2.50	2.30	2.70	2.70	.40	29.00
Birmingham	10.25	14.125	2.35	3.50*r*	1.98*r*	2.09	1.98	1.98	.32	28.35
Boston	10.00	13.75	1.75	2.50	2.31	2.00‡*h*	3.30‡*uv*	3.30‡*uv*	.25‡	21.00‡
Chicago	10.00	13.75	....	....	....	1.75*hf*	1.74*hf*	1.82*hf*	.33*f*	23.00*f*
Cincinnati	10.00	13.75	1.70	2.90	1.60	2.20	2.10*h*	2.10*h*	.33	25.00
Cleveland	10.00	13.75	1.70	2.90	1.60	1.80	1.71*h*	1.71*h*	.26	25.00
Dallas	10.00	14.50	1.88	2.11*n*	.05*l*	1.75*h*	1.66*h*	1.66*h*	.35	39.00
Denver	10.50	14.25	....	....	.27*l*	2.45	2.95	2.95	.35	28.00
Detroit	10.00	13.75	1.75	3.00	1.60	2.25	2.25	2.25	.50	23.00
Kansas City	10.00	13.875	2.30*g*	2.55*gr*	2.16*g*	2.19	2.30	2.30	.28	27.50
Los Angeles	10.25	14.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	10.00	13.875	....	....	....	1.7123*i*	1.6243*hi*	1.6243*hi*	.32	23.00
Montreal	......	11.05	2.50*p*	4.90*p*	3.15*p*	4.02*t*	2.58*t*	3.01*t*	.89*t*	2.10*kl*
New York	10.00	13.75	2.03	....*r*	1.82	1.7098	1.6273*a*	1.6273*o*	.26	23.00
Philadelphia	10.00	13.75	1.60/1.80	2.20*r*	1.55	2.25	2.71	2.71	.32	23.00
Pittsburgh	10.00	13.75	1.05	1.95	.80	1.95	1.84*h*	1.84*h*	.34	26.00
St. Louis	10.00	13.75	2.28*s*	2.89*s*	1.96*s*	1.92	1.66	1.66	.36	24.00
San Francisco	10.25	14.00	1.80	2.75*n*	1.35	1.71	2.40	2.40	.33	20.50
Seattle	10.25	14.25	1.90	3.00	....	2.15	2.16*h*	....	.35	26.50*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb. *m* Per bbl. *n* May, 1941 price. *o* 60-lb. roll. *p* Plus 8% sales tax. *r* Not available, except on priority rating; then quoted specially. *s* December, 1942 price. *t* Federal tax included. *u* 90-lb. roll. *v* Truck delivery.

SKILLED AND COMMON WAGE RATES—PER HOUR

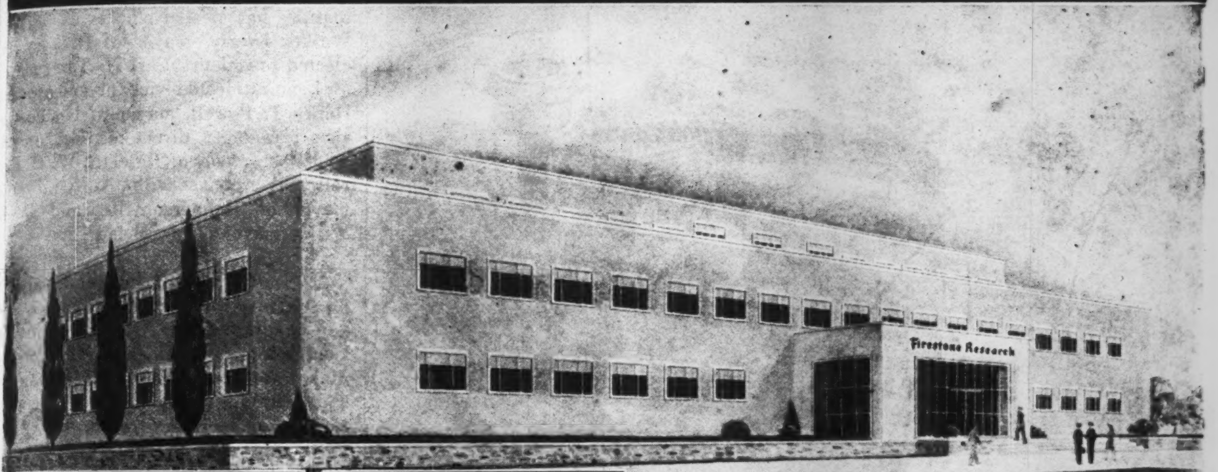
	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.50	$1.25	$1.50	$1.25	$1.50	$0.40	$0.50
Baltimore	1.75	1.4375	1.80	1.625/1.80	1.725	.80	.80
Birmingham	1.75	1.25	1.625	1.375 /1.625	1.65	.65	.65
Boston	1.625	1.50	1.675	1.50 /1.875	1.667	1.00	1.00
Chicago	1.90	1.775	1.85	1.85	1.85	1.20	1.20
Cincinnati	1.825	1.60	1.725	1.45 /1.60	1.75	.90	.90
Cleveland	1.875*c*	1.575	1.875	1.875	1.875	1.085	1.125/1.155
Dallas	1.625	1.25	1.50	1.75	1.625	.60	.75 /1.25
Denver	1.80*b*	1.50*b*	1.50*b*	1.50 /1.625*b*	1.65	.80*b*	.80*b*
Detroit	1.725	1.50	1.825	1.675/1.825	1.725	1.00	1.00
Kansas City	1.75	1.575	1.70	1.675	1.75	.975	.90
Los Angeles	1.50	1.35	1.625	1.375	1.667	.875	.875
Minneapolis	1.625	1.44	1.625	1.50	1.625	.95	.95
New Orleans	1.625	1.375	1.625	1.55	1.50	.70	.80
New York	2.00*b*	1.85*b*	2.00	2.00*b*	2.00*b*	1.10	1.10
Philadelphia	2.00	1.58	1.90/2.00	2.25	2.00	.90	.90
Pittsburgh	1.90	1.75	1.75	1.8125	1.875	1.00	.90
St. Louis	1.90	1.70	1.75	2.00	1.75	1.00	1.00
San Francisco	1.875	1.50	1.75	1.50/1.75	1.75	1.00	1.00
Seattle	1.845	1.545	1.745	2.00	1.845	1.145	1.145
Montreal*	1.06	.96	1.01	.91	1.06	.61	.66

b 7 hr. day. *c* Prevailing rate on government work.
* Cost of living bonus now including in basic wage.



ENR Skilled Average; (Bricklayers, Carpenters, Ironworkers) $1.668.
ENR Common Average; $0.916.

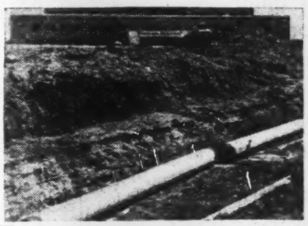
RIC-WIL STEAM CONDUIT CONNECTS NEW Firestone RESEARCH LABORATORY TO CENTRAL BOILER PLANT ONE MILE AWAY


Firestone Research

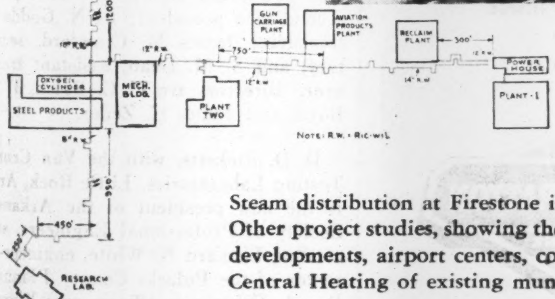
Architects, Vorhees, Walker, Foley and Smith, New York City. Engineered by Firestone.

Installing Ric-wiL Prefabricated Insulated Conduit on steam line to Firestone Laboratory. Note pipe and casing anchored at 45° offset.

Ric-wiL Prefabricated Expansion Loop "cold sprung" into position. Loops are fitted with drive couplers for easy assembly to straight runs.



Ric-wiL Prefabricated Insulated Pipe Units are factory-presealed and delivered to job site in convenient 21 foot-lengths for speedy installation.


SYNTHETIC
PLANTS
250'
1000'
300'
1200'
10" R.W.
12" R.W.
OXYGEN CYLINDER
STEEL PRODUCTS
MECH. BLDG.
PLANT TWO
GUN CARRIAGE PLANT
AVIATION PRODUCTS PLANT
750'
12" R.W.
RECLAIM PLANT
14" R.W.
300'
12" R.W.
POWER HOUSE
PLANT - 1
8" R.W.
950'
450'
250'
RESEARCH LAB.
NOTE: R.W. = RIC-WIL

The very latest developments in building design and services have been incorporated in the magnificent new Firestone Research laboratory. The objective was to provide the utmost in comfort for the chemists, physicists, engineers and technicians, and to supply those many services required in research work.

After an exhaustive study, it was determined that instead of a boiler plant at the site, it would be more practical to extend a steam line from the nearest factory building 2100 feet away, and thus obtain heat and power from the main power plant over a mile to the north. Steam is delivered to the laboratory in 8" Ric-wiL Prefabricated Insulated Pipe, at 180 P.S.I.

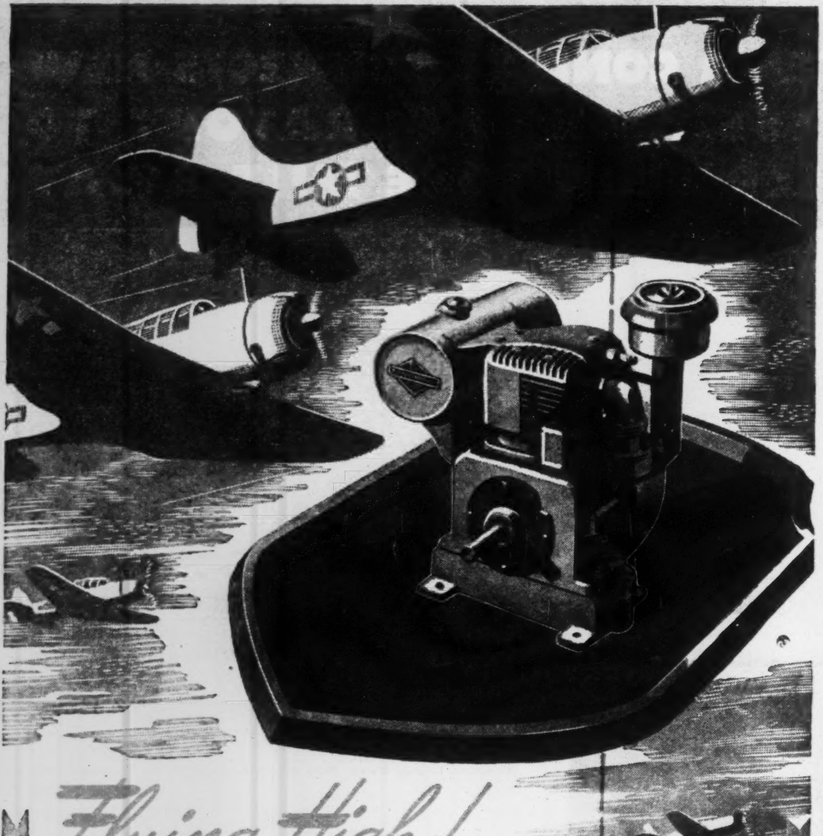
Every building in the vast Firestone Akron industrial community obtains its steam from one central plant. Schematic plot plan at left shows distribution lines—practically all of which are now in Ric-wiL Prefabricated Insulated Pipe Conduit.

Steam distribution at Firestone is described in detail in a booklet now in preparation. Other project studies, showing the application of Central Heating to community housing developments, airport centers, commercial groups, shopping centers and conversion to Central Heating of existing municipalities or neighborhoods, are available on request.

RIC-WIL INSULATED PIPE CONDUIT SYSTEMS

THE RIC-WIL COMPANY · CLEVELAND, OHIO

AGENTS IN PRINCIPAL CITIES



Flying High!

AIRCRAFT ENGINES KEPT PURRING WITH *CLEAN* OIL

To keep fighters and bombers flying from far-flung bases the world over, the lubricating oil for aircraft engines is kept clean by frequent filtering with portable units powered by gasoline engines. One more of many standard and special applications for Briggs & Stratton 4-cycle *air-cooled* gasoline engines.

Everywhere they continue to establish new performance records—adding to their reputation as the world's finest small air-cooled engines—forcasting greater utility than ever before on a steadily increasing number of gasoline-powered appliances and equipment.

Air-Cooled Power 4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES

Briggs & Stratton leadership in design, engineering and precision manufacture is the result of a quarter-century of *continuous* production of *"air-cooled power."* Manufacturers and users of all types of equipment requiring dependable, compact gasoline powered units will find it profitable to call for this experience to help them solve their power problems.

BRIGGS & STRATTON CORPORATION, Milwaukee 1, Wis., U.S.A.

Elections and Activities

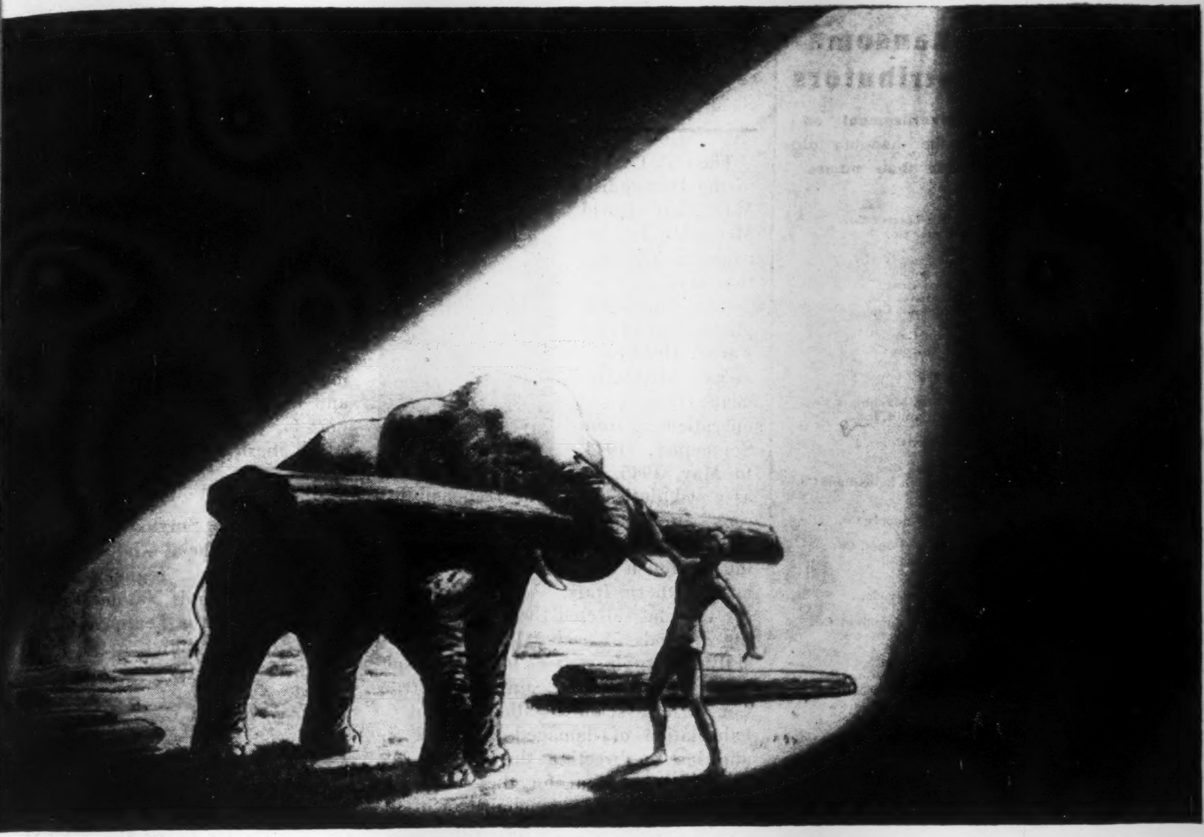
The North Carolina League of Municipalities has elected officers as follows: Walker Lyerly, mayor of Hickory, re-elected president; Earl H. Tate, mayor of Lenoir, elected vice president; and Henry T. Powell, mayor of Henderson, vice president; directors: Graham A. Andrews, mayor of Raleigh, W. C. Farrell, mayor of Nashville, A. V. Edwards, mayor of Hendersonville, and D. B. Willis, mayor of Morehead City.

L. H. Hoffman of Portland, Ore., is president of the Building Division, Oregon chapter of the Associated General Contractors of America, succeeding Max Lorenz. Charles B. Wegman became vice president and J. M. Scudder remains as secretary-treasurer.

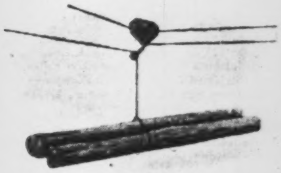
Officers and directors of the Grand Rapids, Mich., Engineers Club for 1945-46 are: President, Otto S. Hess, engineer-manager Kent County Road Commission; vice president, Henry C. Worfel; and secretary and treasurer, Bernard Moll, sanitary engineer, Grand Rapids. Directors: Glenn M. Hammon, chief engineer, Grand Rapids Division, Michigan Consolidated Gas Co., E. F. Roosa, division engineer, Consumers Power Co., Albert J. DeRuiter, structural engineer, Grand Rapids Steel & Supply Co., Thomas D. Stafford, Alexander-Stafford Corp.

Harold S. Ellington, of Harley, Ellington and Day, architects and engineers, has been elected president of the Engineering Society of Detroit, Mich. Other officers are: C. J. Freund, first vice president; George R. Thompson, second vice president; A. N. Goddard, treasurer; James M. Crawford, secretary, and S. M. Dean, assistant treasurer. Directors are E. C. Balch, T. A. Boyd, and James C. Zeder.

D. D. Ricketts, with the Van Crump Testing Laboratories, Little Rock, Ark., is the new president of the Arkansas Society of Professional Engineers, succeeding Leonard N. White, engineer-director of the Pulaski County Planning Board. Other new officers are: Werner C. Knoop, consulting engineer; first vice president; W. G. Huxtable, chief engineer for the St. Francis Levee District, 2nd vice president; R. M. Newsom of the Arkansas Highway Department, secretary-treasurer; and B. Frank Beckman, Ft. Smith, and G. M. Swilley, El Dorado, directors.



Wire rope toughness means *Long* useful life!



Thousands of wire rope users—old hands and new—have found our specially prepared manual, "Know Your Ropes" valuable in making their work easier and prolonging rope life. It contains 78 "right and wrong" pictures, 40 wire rope life savers, 20 diagrams, tables and charts. Send for your FREE COPY today.

Only by selecting wire rope of the proper strength and toughness can you secure true rope economy—long, useful life! For built-in strength and toughness give wire rope the *reserve* resistance which means greater rope efficiency.

Strength and toughness are put into wire rope when the steel is refined and processed. Here quality begins with the scientific blending of the proper ingredients in their correct proportion to produce the one wire rope best suited for *your* specific purpose.

Metallurgical research and control are *added* ingredients of every Wickwire Rope. This close watch over quality continues through the production of the correct alloy for use in each type, size and construction of wire rope, and then through each successive step of wire drawing and wire rope manufacture.

WICKWIRE SPENCER

WICKWIRE SPENCER *Steel Company*

500 FIFTH AVENUE, NEW YORK (18), N. Y.

ILENE • BOSTON • BUFFALO • CHATTANOOGA • CHICAGO • CLINTON (MASS.) • DETROIT • HOUSTON • LOS ANGELES • PHILADELPHIA • SAN FRANCISCO • TULSA • WORCESTER

Worthington-Ransome Blue Brute Distributors

By referring to the advertisement on page 141, you'll learn the meaning of the (1), (2) or (1-2) beside their names.

Ala., Birmingham (1) J. D. Pittman Tractor Co.
Ariz., Phoenix (2) Smith Booth Usher Co.
Ark., Fort Smith (2) R. A. Young & Son
    Little Rock (1) Kern-Limerick, Inc.
    Little Rock (2) R. A. Young & Son
Calif., Los Angeles (1) Garlinghouse Bros.
    Los Angeles (2) Smith Booth Usher Co.
    San Francisco (2) Coast Equipment Co.
Colo., Denver (2) John N. Meade
    Denver (1-2) Power Equipment Co.
Conn., Hartford (2) The Holmes-Talcott Co.
    New Haven (1) W. I. Clark
    Waterbury (1) Contractors Supply Co.
Del., Smyrna (1) King-Burrous
D. C., Washington (1) M. A. Doetsch Machinery Co.
Fla., Jacksonville (1) Julien P. Benjamin, Inc.
    Tampa (2) S. M. Regar
Ga., Atlanta (2) Tractor & Machinery Co.
    Savannah (1) Morgans, Inc.
Ida., Boise (1-2) Olson Manufacturing Co.
Ill., Chicago (1-2) Chicago Construction Equipment Co.
    Chicago (2) John A. Roche
    Chicago (1) Thomas Hoist Co.
Ind., Fort Wayne (1) American Steel Supply Co.
    Indianapolis (2) Reid-Holcomb Co.
Iowa, Des Moines (2) Electric Eng. & Const. Co.
Ky., Harlan (2) Hall Equipment Sales Co.
    Louisville (2) T. C. Coleman & Son
    Louisville (2) Williams Tractor Co.
    Paducah (1) Henry A. Petter Supply Co.
La., New Orleans (1) Ole K. Olson Co.
    New Orleans (2) Wm. F. Surgi Equipment Co.
Maine, Portland (1-2) Maine Truck-Tractor Co.
Md., Baltimore (1) Stuart M. Christhilf & Co.
    Baltimore (2) D. C. Elphinstone, Inc.
Mass., Boston, Allston (1-2) Clark-Wilcox Co.
    Cambridge (2) W. W. Field & Son, Inc.
Mich., Detroit (1) T. G. Abrams
    Detroit (2) W. H. Anderson Co., Inc.
    Flint (2) Gransden-Hall & Co.
    Muskegon (1-2) Lakeshore Machinery & Supply Co.
Minn., Minneapolis (1-2) Phillippi-Murphy Equipt. Co.
    St. Paul (2) D. L. O'Brien
Miss., Jackson (1) Jackson Road Equipment Co.
Mo., Clayton (1-2) The Howard Corporation
    Kansas City (1) Brown-Strauss Corp.
    Kansas City (2) Machinery & Supplies Co.
    St. Louis (2) W. H. Reaves
Neb., Lincoln (1) Highway Equipment & Supply Co.
N. J., Hillside (2) P. A. Drobach
    Newark (1) Johnson & Dealaman
    North Bergen (2) American Air Compressor Corp.
N. M., Albuquerque (2) Bud Fisher Co.
    Albuquerque (1) Morrow & Co.
    Roswell (2) Smith Machinery Co.
N. Y., Albany (1-2) Milton-Hale Machinery Co.
    Buffalo (2) Dow & Co., Inc.
    New York (2) Air Compressor Rental & Sales
    New York (1-2) Hodge & Hammond, Inc.
    New York (1-2) Railroad Materials Corporation
    Olean (2) Freeborn Equipment Co.
N. C., Raleigh (2) Carolina Tractor & Equipment Co.
N. D., Fargo (1-2) Smith Commercial Body Works, Inc.
O., Cincinnati (2) Finn Equipment Co.
    Cleveland (2) S. M. Clancey
    Cleveland (1) H. B. Fuller Equipment Co.
    Cleveland (2) Gibson-Stewart Co.
    Marietta (2) Northwest Supply & Equipment Co.
    Toledo (1) Edmund Supply Co.
    Toledo (2) M. W. Kilcorse & Co.
Okla., Oklahoma City (2) Townsco Equipment Co.
Oregon, Portland (2) Andrews Equipment Service
Pa., Allentown (2) H. N. Crowder, Jr., Inc.
    Easton (2) Sears & Bowers
    Harrisburg (2) N. A. Coulter
    Oil City (2) Freeborn Equipment Co.
    Philadelphia (1) Giles & Ransome
    Philadelphia (2) Metalweld, Inc.
    Pittsburgh (2) Atlas Equipment Corp.
    Wilkes-Barre (2) Ensminger & Co
    Wilkinsburg (1) Arrow Supply Co.
    York (2) George F. Motters Sons
S. C., Columbia (2) Smith Equipment Co.
Tenn., Knoxville (2) Wilson-Weesner-Wilkinson
    Memphis (2) Tri-State Equipment Co.
Tex., Dallas (1) Service Equipment Co.
    Dallas (2) Shaw Equipment Co.
    El Paso (2) Equipment Supply Co.
    El Paso (1) Mine and Smelter Supply Co.
    Houston (2) Dye Welding Supply Co.
    Houston (1) McCall Tractor & Equipment Co.
    San Antonio (2) Patten Machinery Co.
    San Antonio (1) San Antonio Machine & Supply Co.
Utah, Salt Lake City (1-2) Landes Engineering Co.
Vt., Barre (1-2) A. M. Flanders, Inc.
Va., Richmond (2) Highway Machinery & Supply Co.
Wash., Seattle (1) Columbia Equipment Co.
    Seattle (2) Star Machinery Co.
    Spokane (2) Andrews Equipment Service
    Spokane (1) Columbia Equipment Co.
W. Va., Charleston (1) West Virginia Co.
    Fairmont (2) Interstate Engineers & Constr., Inc.
Wisc., Milwaukee (1) Mekeel Engineering Co.
Wyoming, Cheyenne (2) Wilson Equipment & Supply Co.

BUY BLUE BRUTES

Worthington Pump and Machinery Corp.

Worthington-Ransome Construction Equipment Division
Holyoke, Massachusetts

MEN AND JOBS

The Oak Leaf Cluster has been added to the Distinguished Service Medal of Maj. Gen. David McCoach, Jr., because, as the citation says,

"As Chief Engineer, Allied Force Headquarters, Mediterranean Theater of operations, from September, 1944, to May, 1945, he assumed duties of great responsibility soon after the invasion of Southern France while Allied troops were preparing to launch an offensive in mountainous Northern Italy. Although pressed for time he selected the best engineering methods of each Allied army and skillfully applied them to major problems in engineering supply, construction of large-scale installations and rehabilitation of damaged facilities. In addition to directing the military engineering program for the Mediterranean Theater, he was chairman of the Power Commission of the Allied Commission in Italy when it solved the tremendous problem of reconstructing industrial power and light plants.

"He furnished valuable advice to the Commission in planning the return to Italian control of roads and bridges which were under military supervision. The diplomacy, wide technical knowledge and ability to meet emergencies demonstrated by him welded the activities of Allied engineering units in the Mediterranean Theater into a firm, efficient organization and materially contributed to the defeat of the enemy in that area."

James A. Davis, active in highway construction in Washington state and Alaska, has been named acting director of the Washington State Department of Highways. He was promoted from assistant highway director. Graduated from Washington State College in 1909, Davis became city engineer at Ritzville, Wash., and later engaged in railroad and water supply engineering. He entered the highway department as a draftsman in 1913 and served as resident and locating engineer, office engineer, chief draftsman, district engineer, construction engineer, assistant state highway commissioner, chief engineer, assistant director of highways and acting director of highways.

The Army Corps of Engineers will open a suboffice in Indianapolis, Ind., soon with **Robert Walker** in charge Mr. Walker, now stationed at Vincennes, has had more than 16 years service with the Army Engineers at the Louisville, Ky. district office, the Huntington W. Va. district and the New Orleans, La. district. He participated in the engineers' flood fights along the Ohio and Wabash basins during the inundations of '43, '44 and '45 and also assisted in preparing the report for flood prevention projects along the Wabash River in Indiana.

Col. Richard Smykal, former Chicago construction official who was one of the youngest pre-war regimental commanders in the Illinois National Guard, has been awarded the Legion of Merit and made Deputy Chief of Staff of the United States Chinese Combat Command.

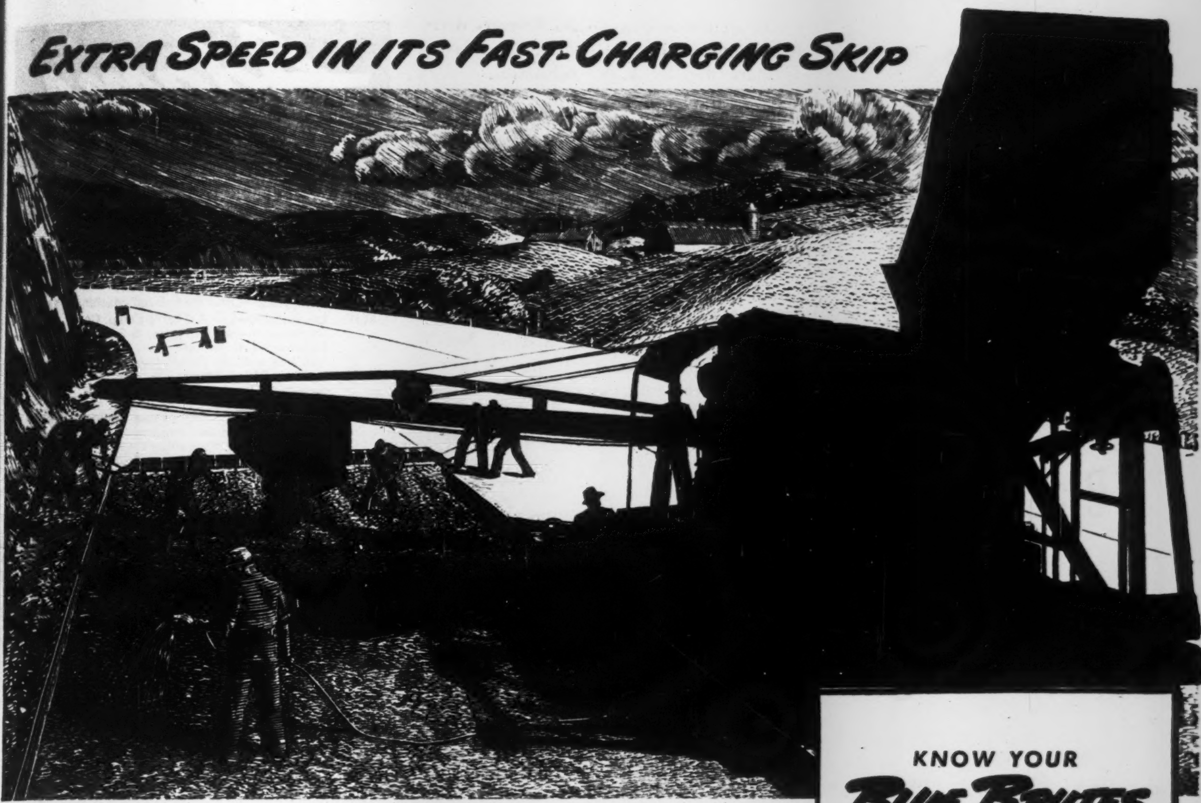
Col. Jack Pickens of Little Rock, Ark., recently released from the Army, has formed a partnership with S. F. Ditmars and John Dickmann of Muskogee, Oklahoma, to be known as Ditmars, Dickmann, Pickens Construction Co., with offices in the Gazette Building, Little Rock. Ditmars and Dickmann will also maintain offices in Muskogee.

W. J. Van London, former district engineer for the Texas Highway Department at Houston, has become engineer-manager of the Houston urban expressway project, under an appointment from the highway commission. **Jas. Douglas,** now state construction engineer, will succeed Mr. Van London as head of the Houston district. He formerly held that position, and also served as engineer for the Amarillo and Tyler districts.

H. R. Chapin, Roseau, Minn., has been appointed county highway engineer of Roseau County. He has been with the state highway department for many years.

Horace Waldo Fleming has been appointed engineer of maintenance of way for the Central region of Canadian National Railways, with headquarters at Toronto, succeeding **E. R. Logie** who has been advanced to chief engineer of the region. Mr. Fleming has been for some years district engineer for the southern Ontario district, in which post

EXTRA SPEED IN ITS FAST-CHARGING SKIP



There are many reasons why this Ransome 34-ft. E Blue Brute "Dual Drum" Paver has the reputation for laying more footage per day than any other paver. But let's start at the beginning . . . with the skip.

Because the drum that receives the charge has a larger opening than other pavers, the skip's throat is wider. Add a 56 degree skip slope . . . steepest on any paver . . . and you can see why the charge wastes no time entering the mixer drum.

SKIP IS FOOL-PROOF, TOO

Slotted pivot bearings that allow skip to adjust itself on uneven subgrade to prevent warping and twisting when batch trucks back into it . . . *6" grill* that prevents damaging foreign material from entering mixer with aggregate . . . *low overhead framework* that permits paver to move through limited clearances — these features give extra insurance of trouble-free operation and longer life.

OTHER EXCLUSIVE BLUE BRUTE FEATURES

This "Dual Drum" Paver also has *hydraulically-controlled boom bucket* for laying any part of load where you want it even while speedy *hydraulically-operated boom* is swinging . . . *renewable boom track* . . . *metal-to-metal spiral cut-off in tank* for continued precision of water measuring . . . *mechanically-operated batch meter* for all-season accuracy — all adding up to more footage per day and lower maintenance cost per year.

R5-1

KNOW YOUR BLUE BRUTES

Your Blue Brute Distributor will gladly show you how Worthington-Ransome Blue Brute construction equipment will put your planning on a profitable basis and prove that ***there's more worth in Worthington-Ransome.*** Act now! His name is listed on page 140. The number beside his name indicates the Blue Brutes he handles.

1.

Blue Brutes include: Pavers, Concrete Spreaders**, Concrete Mixers, Concrete Placing Equipment, Big Mixers, Finishing Machines**, Pneumatic Placing & Grouting Equipment, Truck Mixers, Plaster & Bituminous Mixers, and accessories.

2.

Blue Brutes also include: Diesel, gasoline and electric driven Portable Compressors from 60 to 500 cu. ft. capacity in mountings to suit all jobs; Rock Drills and Air Tools in a wide range of weights and sizes; Contractors' Pumps.**

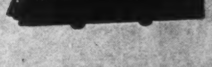
**Postwar Products

BUY BLUE BRUTES

Truck Mixers
Capacities:
2, 3, 4½, 5½ cu. yds.

Portable Mixers
Capacities:
3½, 7, 10, 14 cu. ft.

Big Stationary Mixers
Capacities:
28, 56, 84, 126 cu. ft.



Pneumatic Placer
Capacity:
7, 14, 28 cu. ft.

WORTHINGTON

Worthington Pump and Machinery
Corporation, Worthington-Ransome
Construction Equipment Division
Holyoke, Mass.

Black on White for Better Sight

WYTEFACE "A" Steel Tapes have *raised* black graduations on a crack-proof white surface. Easy to read in any light, from any angle. Faster measurements with fewer errors. Designed for hard service. White background is protected by raised steel markings and rims. Resists abrasion from rails, pipe, rocks, concrete. Protected against rust. See your dealer. Write for catalog.

K+E

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Reproduction
Surveying Equipment and Materials
Slide Rules
Measuring Tapes

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WYTEFACE "A"
TRADEMARK
STEEL MEASURING TAPES

he is succeeded by **G. K. Fraser**, divisional engineer at Belleville. Mr. Fraser is succeeded by **A. V. Johnston.**

Paul W. Masters, bridge engineer for the Utah State Road Commission, resigned recently to join the United States Smelting & Mining Co. as structural engineer. He is succeeded by **O. T. Peterson**, former employee of the highway department.

At the same time Chief Engineer Roy W. McLeese announced the appointment of **Don Miles** as acting district No. 4 engineer at Price, replacing **William Osborne** who became assistant location engineer. Mr. Miles was traffic safety engineer and was succeeded by **Harry Wright.**

David H. Harker, engineer and chief of staff of the Ohio Water Supply Board since its organization in 1942, has resigned, effective as soon as a successor is named. He will become chief engineer of the newly created Indiana Flood Control and Water Resources Commission.

L. C. Jacobson recently became a partner in the Del E. Webb Construction Co. of Phoenix, Ariz. Previously in the contracting business in Tuscon, Ariz., he became associated with the Webb company in 1938. The firm, now engaged in constructing the Mitchell Convalescent Hospital at San Diego, Calif., has built Luke Field and Williams Field at Phoenix, Kingman Airbase, Florence Prisoner of War Camp, Poston relocation centers, Yuma Airbase, five Marine Corps stations and six housing projects in various sections of California.

J. L. Charles has been appointed chief engineer, Western Region, Canadian National Railways, with headquarters at Winnipeg, Man., succeeding J. W. Porter, retired.

Capt. William J. Derksen, officer in charge of the control division of the U. S. Engineer Corps district, Duluth, Minn., succeeds **Maj. U. A. Graff** as executive officer of the division. Maj. Graff will take over contract terminations for the U. S. Engineers' procurement office at Columbus, Ohio, after a six-weeks orientation course at Georgetown University, Washington.

A. S. Miller, County Engineer of Northumberland and Durham Counties, Cobourg, Ont., has resigned.

E. F. Wright, assistant engineer of the Baltimore and Ohio Railroad at Pittsburgh, Pa., has been appointed regional engineer there.

Adams
DISTRIBUTORS
Headquarters for
MACHINERY and SERVICE

ALA.	Montgomery—Ray-Brooks Machinery Company Birmingham—Tractor & Equipment Company
ALASK.	Fairbanks—Glenn Carrington & Company
ARIZ.	Phoenix—O. S. Stapley Company
ARK.	Little Rock—Little Rock Road Machinery Co.
CALIF.	Los Angeles—Lee & Thatro Equip. Co. Sacramento—Sutton Tractor & Equipment Company Redding—J. G. Bastain San Jose and San Francisco—Valley Equipment Co. Fresno—Brown Tractor Co. Stockton—Thompson-Sage, Inc. Salinas—Farmers Mercantile Co. Santa Rosa—Stevenson Farm Equipment Co. Modesto—Stanislaus Implement & Hardware Co. Visalia—Exeter Mercantile Co. Merced—Gallagher Tractor & Implement Co.
COLO.	Denver—McKelvy Machinery Company
CONN.	New Haven—W. I. Clark Company
DEL.	Phillips Machinery & Tractor Co., Baltimore
FLA.	Jacksonville, Miami, Tampa—Florida Equipment Co. Pensacola—Ray-Brooks Truck & Tractor Company
GA.	Atlanta—Tri-State, Inc.
IDA.	Boise & Pocatello—Intermountain Equipment Co.
ILL.	Peoria & Springfield—A. E. Hudson Company Salem—E. W. Werner Motor Company Chicago—Great Lakes Supply Corp.
IND.	Indianapolis—Indiana Equipment Co., Inc.
IOWA	Des Moines—Herman M. Brown Company
KANS.	Wichita—S. H. Denney Road Machinery Co.
KY.	Louisville—Brandeis Machinery & Supply Co.
LA.	Baton Rouge & Monroe—Dunham-Pugh Co.
MAINE	Portland—Maine Truck-Tractor Co.
MD.	Baltimore—Phillips Machinery & Tractor Co.
MASS.	Newton Highlands—Tractors, Inc.
MICH.	Bark River—Bark River Culvert & Equipment Co. Detroit and Grand Rapids—Wolverine Tractor & Equipment Co.
MINN.	Minneapolis & Duluth—Rosholt Equipment Co.
MISS.	Jackson—Mississippi Road Supply Co.
MO.	St. Louis—Missouri-Illinois Tractor & Equip. Co. Kansas City—Noel V. Wood, Inc.
MONT.	Billings & Missoula—Industrial Equipment Co.
NEB.	Omaha—Nebraska Tractor & Equipment Company North Platte—Cornhusker Tractor & Equip. Co.
NEV.	Reno—Allied Equipment, Inc.
N. H.	Manchester—R. C. Hazelton Co.
N. J.	Trenton—Ross, Young, Dilts Company
N.M.	Albuquerque—Hardin & Coggins
N. Y.	Buffalo—Dow & Company, Inc. Brooklyn—Edward Ehrbar, Inc. Long Island—George Malvese & Co. Albany, Syracuse—Milton-Hale Mach. Co.
N. C.	Raleigh—J. B. Hunt & Sons
N. D.	Fargo—Myhra Equipment Company
OHIO	Cleveland—Gibson-Stewart Company Cincinnati—Rish Equipment Co. Cambridge—Major Equipment Co.
OKLA.	Tulsa & Guthrie—C. L. Boyd Company, Inc.
ORE.	Portland & Eugene—Howard-Cooper Corporation
PA.	Butler—National Equipment Co. Pittsburgh—Atlas Equipment Corp. Philadelphia—Service Supply Corp. Harrisburg & Wilkes-Barre (Kingston)—State Equipment Co.
R. I.	Providence—Tractors, Inc.
S. C.	Columbia—N. H. Summers Road Machinery Co.
S. D.	Sioux Falls, Rapid City—Empire Equipment Company
TENN.	Knoxville & Chattanooga—Brooks Equip. & Mfg. Co. Nashville—Industrial Tractor & Equipment Co., Inc. Memphis—Road Builders Equipment Co.
TEXAS	Dallas & Houston—Browning-Ferris Machinery Co. San Antonio—Jess McNeel Machinery Co. Plainview & Sweetwater—Plains Mach. Co.
UTAH	Salt Lake City—The Lang Company
VA.	Richmond—Municipal Sales Company Richmond and Roanoke—Rish Equipment Co. Alexandria—Phillips Mach. & Tractor Co.
WASH.	Seattle—Howard-Cooper Corp. Spokane—Intermountain Equip. Co.
W. VA.	Charleston and Clarksburg—Rish Equipment Co.
WIS.	Eau Claire—Bark River Culvert & Equipment Co.

SEE **Adams**
AD ON OPPOSITE PAGE

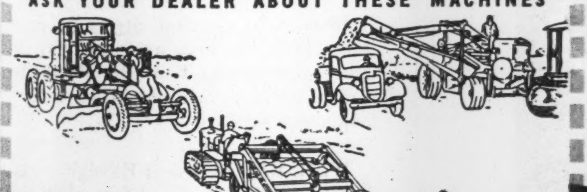
Easily Operated in the Roughest Going!

Yes, Adams Motor Graders are engineered for fast, easy operation—even in the roughest kind of going. Here are just a few salient features:

- **Efficient Push-Button Starting Arrangement:** Starts heavy-duty Diesel engine quickly, easily—regardless of weather or temperature—right from the cab.
- **Big, Comfortable Cab:** Wide, adjustable seat—Plenty of room for stand-up or sit-down operation—All operating controls within easy reach.
- **Positive Mechanical Steering System:** Mounted throughout on anti-friction bearings—Provides easy steering with *safe control* under all conditions—*at all speeds.*

Ease of operation is just one more reason why rugged, multiple-duty Adams Motor Graders are the wise choice for high-speed efficiency and economy. Ask your local Adams dealer for convincing proof.

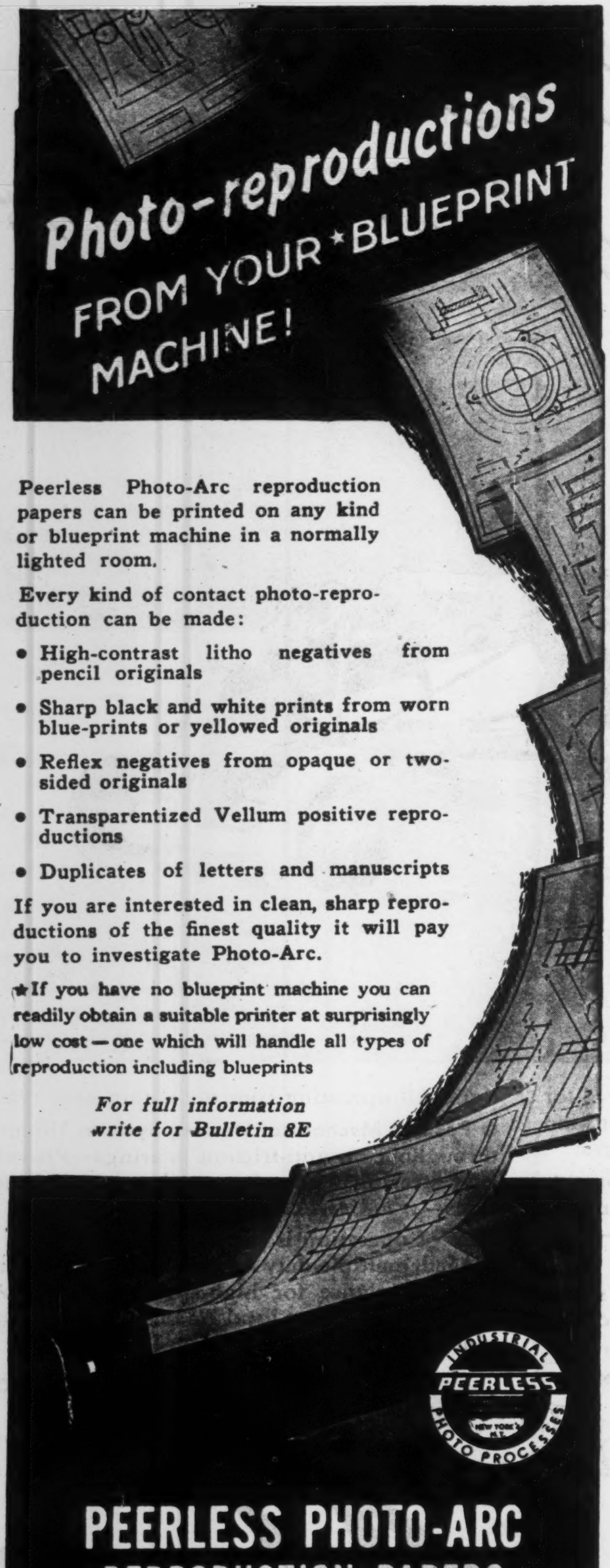
ASK YOUR DEALER ABOUT THESE MACHINES



J. D. ADAMS MANUFACTURING CO.
INDIANAPOLIS, INDIANA
Sales and Service Throughout the World

Adams

ROAD-BUILDING AND EARTH-MOVING EQUIPMENT



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Peerless Photo-Arc reproduction papers can be printed on any kind or blueprint machine in a normally lighted room.

Every kind of contact photo-reproduction can be made:

- High-contrast litho negatives from pencil originals
- Sharp black and white prints from worn blue-prints or yellowed originals
- Reflex negatives from opaque or two-sided originals
- Transparentized Vellum positive reproductions
- Duplicates of letters and manuscripts

If you are interested in clean, sharp reproductions of the finest quality it will pay you to investigate Photo-Arc.

★If you have no blueprint machine you can readily obtain a suitable printer at surprisingly low cost — one which will handle all types of reproduction including blueprints

For full information write for Bulletin 8E

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PEERLESS PHOTO-ARC
REPRODUCTION PAPERS

Manufactured only by
PEERLESS PHOTO PRODUCTS, INC.
50 Broadway, New York 4, N. Y.

L. G. Williams is now associated wtih Jones and Henry, consulting hydraulic and sanitary engineers, Toledo, Ohio. For sixteen years he was with Greeley and Hansen, consulting engineers of Chicago and was resident representative on the Lake Erie Water Project at Toledo and since the war, on water and sewerage projects in the Hampton Roads area of Virginia. Former engagements included hydraulic engineer with the City of Long Beach, Calif., junior assistant sanitary engineer with the Public Health Service on the Illinois River Investigation; and assistant engineer with the Engineering Experiment Station, Ames, Iowa.

William Muirhead, Durham, N. C., contractor, is overseas on a special mission for the U. S. Government. President of the William Muirhead Construction Co., he recently completed a term as president of the Associated General Contractors of America. **Hal S. Crain,** executive vice president, has assumed management of the company in Muirhead's absence.

City engineers have been named by two Washington state cities—Centralia and Kelso. Centralia appointed **Charles C. Smartwood** to succeed **Roy A. Welsh** while Kelso retained **George H. Brown.**

William Zeigler, a former structural engineer for Freese & Nichols, Ft. Worth, Tex., has been appointed district engineer by the American Institute of Steel Construction in the Texas-Oklahoma territory. At one time he was manager of the structural engineering department for Robert & Co. at the Naval Air Station at Corpus Christi, Tex.

The U. S. Army Engineers have opened a Southwest Area office in Corpus Christi, Tex. with **Senior Engineer T. W. Forman** in charge. The office is to be in charge of the watershed of rivers south and west of the Colorado and the Mexican border, along with harbor and river work between the Colorado River floodgate and the Mexican border.

Chas. Ash, assistant city engineer of Lima, Ohio, has been appointed city engineer, succeeding **T. A. Monahan,** who has resigned to join the Allen County engineer's staff.

W. H. Rogers, Jr., of Raleigh, N. C., has been appointed assistant chairman of the North Carolina Highway Commission. A graduate of the North Carolina State College School of Engineering in 1916, he served for two years in the Army Engineers Corps during World War 1, was connected with the

N. C. Highway Department in 1920-23, served as engineer of Pitt County, N. C., from 1923 to 1931, when he rejoined the highway department as district engineer.

Howard H. Kramer, former city manager at Milton, Ore., has been appointed city manager of Petoskey, Mich. He succeeds **Peter Mitchell,** resigned.

Carl M. Fonnesbeck of Logan, Utah, is the new engineer of the state road commission's district No. 1 at Ogden, following the resignation of **Fred D. Miles.** Formerly Mr. Fonnesbeck was resident engineer of Cache County.

Carl J. Lenander, 77, Minneapolis, Minn., a retired civil engineer for many years, is back in the harness again, having taken a job as test attendant in the water treatment department of the Twin Cities ordnance plant.

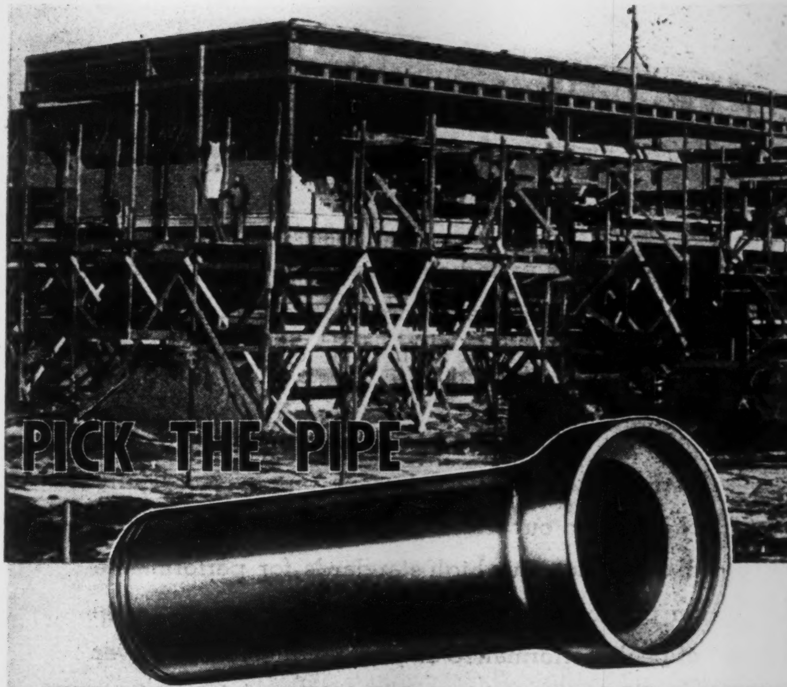
Born in Sweden, at 13, he entered a university and was graduated highest in his class, with a degree in civil engineering. At the Royal Technical Institute in Stockholm, he took post graduate work in engineering. In 1920 he went to Minneapolis and built more than 100 bridges in Hennepin County, including the 11-span Deephaven bridge. Before the present war, Lenander had an engineering business in Minneapolis with his son **Carl J. Lenander, Jr.,** now a major in the 368th Engineers in the Third Army.

Col. Roy Burdick, U. S. Engineers, replaces **Col. Howard H. Davis,** as district engineer at Little Rock, Ark. Colonel Davis will go to Fort Belvoir.

J. Henri Valiquette, city engineer of Grand Mere, Que., has been appointed city manager of Three Rivers, Que.

Samuel P. Kingston, district public health engineer of the state department of health, Rochester, Minn., has been appointed consultant to the water pollution control commission pending the return from military service of **Lieut. Col. Harvey G. Rogers** of the health board's engineering staff, who will get the post upon his return.

Capt. John W. Webb, Jr., of Wilmington, N. C., is commanding a combat engineer company in the Philippine Islands, where he recently was awarded the Bronze Star medal for meritorious achievement in military operations on Luzon. Captain Webb received his degree in civil engineering at The Citadel, Charleston, S. C., in 1942, joining his present unit at Camp Shelby, Miss., in June of that year. He has served in New Caledonia, New Georgia and Bougainville.



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When you specify a pipe to carry industrial waste, the only safe course is to choose *all-purpose pipe*— safe today and safe tomorrow. Because, as many industrial plants have learned too late during this war, a one-purpose pipe, chosen to carry one kind of waste, can quickly go to pieces when called on to carry various acids and alkalies.

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Manufacturers' Publications

Henry A. Marti, Toledo, has assumed his duties as executive vice president and general manager of the Buckeye Traction Ditcher Co., Findlay, Ohio.

The Detroit Diesel Engine division, General Motors Corp., has appointed E. F. Bentley contractors' equipment sales manager. He succeeds A. N. Anderson, now Detroit Diesel Engine dealer in Los Angeles.

Bentley has been associated with diesel divisions of General Motors since 1934. After five years with the Cleveland division he transferred to Detroit, where he served as supervisor of the controlled material plan activities and as a member of the purchasing department, buying all production electrical items.

After rolling up almost 50 years of service in the road roller industry, C. J. Foster, executive officer of The Buffalo-Springfield Roller Co., Springfield, Ohio, is planning to retire at the end of this year. A stock holder in the company, Mr. Foster will continue as a director in an advisory capacity. Mr. Foster joined the O. S. Kelly Co. in 1898. When that concern sold its roller business to the Kelly-Springfield Road Roller Co., he went with the latter concern, now The Buffalo-Springfield Roller Co.

The company is completing an expansion program in anticipation of a heavy demand for equipment for what it believes may be the largest street and road building program in history.

Sale of the Crescent Machine Co., of Leetonia, Ohio, to the Pittsburgh Equitable Meter Co. was a cash consideration of "under $250,000" it is revealed. Crescent's production of wood working machinery will be used to augment the smaller line of the Delta Manufacturing Co., a subsidiary of Pittsburgh Equitable Co., and its foundry will be

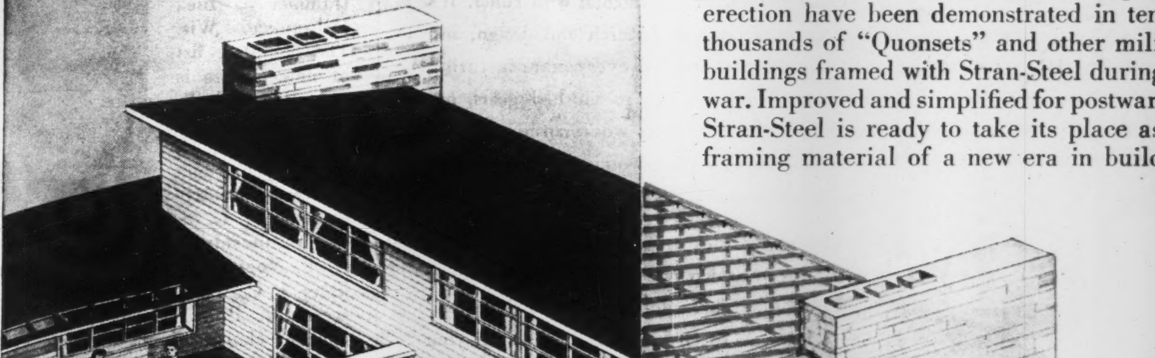
THINK IN TERMS OF

STRAN STEEL

Look beneath the surface for the mark of the progressive builder

That framework of Stran-Steel, with its nailable studs and joists, sets any house apart from others of comparable design. For it imparts an inner value . . . permanence, fire-safety, freedom from warp, sag and rot . . . that safeguards the housing investment and enhances the builder's reputation.

Progressive architects and contractors are thinking in terms of Stran-Steel . . . shaping their building plans around this uniform precision material. Its ease of use and speed of erection have been demonstrated in tens of thousands of "Quonsets" and other military buildings framed with Stran-Steel during the war. Improved and simplified for postwar use, Stran-Steel is ready to take its place as the framing material of a new era in building.



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YOU CAN BET IT'LL BE
QUIET

There's one point about a Fuller Transmission which will always be retained: *quiet running* . . . because noise means vibration and vibration means wear.

Quiet running is fundamental with Fuller. It's the result of years of research and design, and the complete control of every manufacturing operation from forgings to finished gears, not only to assure precision workmanship, but to provide wear life on beyond what you would ordinarily expect.

That's why truck owners say that Fuller Transmissions can be depended upon for thousands of extra miles . . . this evidence is worth remembering when you specify the transmission for your new truck . . . whether you're the buyer or the builder.

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TRANSMISSIONS

TRACK HAULAGE IS CHEAPER HAULAGE

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• FROM 2½ TO 70 TONS •

PLYMOUTH LOCOMOTIVE WORKS
Division of The Fate-Root-Heath Co., PLYMOUTH, OHIO, U. S. A.

used for casting valve and meter parts for the parent concern and the Edwards Valve and Manufacturing Co., another subsidiary.

T. A. Ripley, former manager of the New Comerstown, Ohio, plant of the James F. Clow Sons Co., has been named manager of the former Eddy Valve Co. recently purchased by Clow at Waterford, N. Y. The plant employs 200 men. The Clow firm has sold fire hydrants and valves made by the Eddy concern for several years.

Allied Steel Products Inc. of Cleveland, Ohio, has taken over the exclusive sale of the Pittsburgh-Cambria Steel Co.'s tool steels.

G. S. Crane, formerly vice-president in charge of sales and engineering has been elected president of Cutler-Hammer, Inc., Milwaukee, Wis. The complete list of new officers is as follows. F. R. Bacon, chairman of the board; H. F. Vogt, chairman of the executive committee; G. S. Crane, president; H. F. Vogt, vice president and treasurer; J. C. Wilson, vice president and secretary; P. B. Harwood, vice president in charge of engineering; P. S. Jones, vice president in charge of sales; Philip Ryan, vice-president in charge of manufacturing; E. W. Seeger, vice president in charge of development and assistant secretary; M. R. Fenno, assistant treasurer; and J. C. Springer, assistant secretary.

G. S Crane

F. R. Bacon, the founder of the company, has been president from 1896 to the present time excepting for the period between May, 1924 and April, 1931, when B. L. Worden was president and Mr. Bacon chairman of the board.

H. R. Pittman has been appointed treasurer of the Vulcan Iron Works, Wilkes-Barre, Pa., following the resignation of W. W. Moss. Mr. Pittman has been with the Vulcan Iron Works for 27 years, serving successively as chief clerk, comptroller, and in recent years as both assistant secretary and assistant treasurer.

The Name of the Chamberlain Metal Weather Strip Co., Detroit, Mich., has been changed to Chamberlain Company of America. The company's products and services, in addition to weather strips, include rock wool insulation, storm windows, caulking, insect screens and detention screens for hospitals and psychiatric institutions.

Only oil with a really

stable detergent

gives dependable protection!

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U.S. TRUCK
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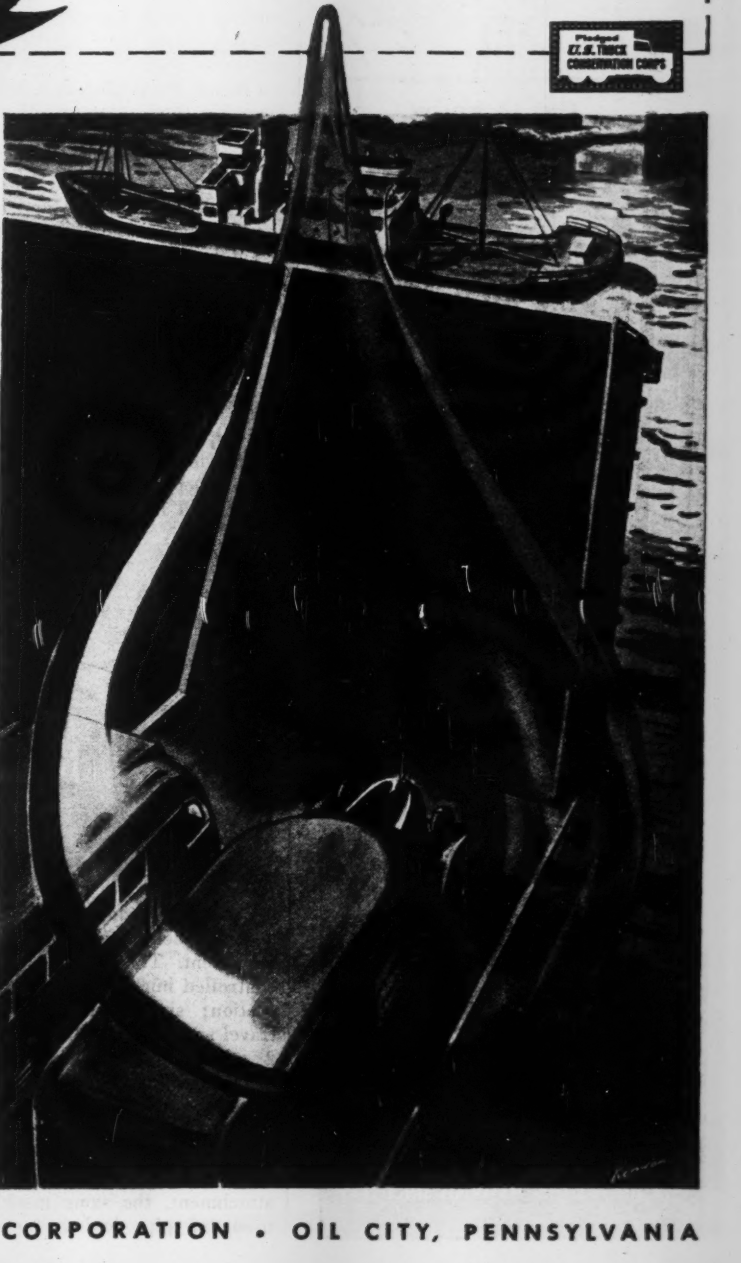

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That is why it is important for you to consider seriously what *Quaker State HD Oil*—made especially for your over-worked equipment—can do for you.

Quaker State HD Oil contains a special detergent that keeps engines cleaner—prevents soot, fuel residues, road dust and dirt, which may accumulate in the oil, from sticking to engine surfaces and building up harmful deposits.

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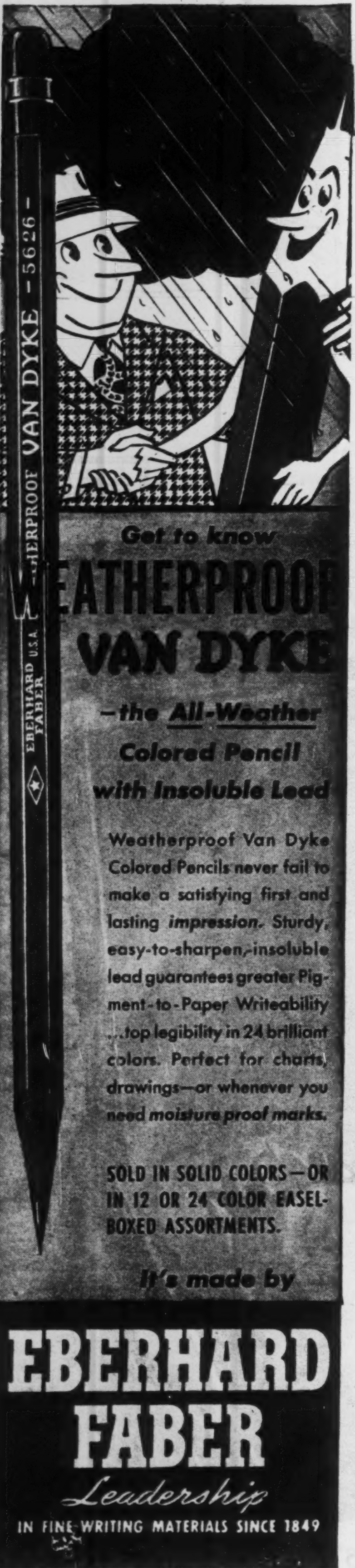

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Weatherproof Van Dyke Colored Pencils never fail to make a satisfying first and lasting *impression.* Sturdy, easy-to-sharpen, insoluble lead guarantees greater Pigment-to-Paper Writeability ...top legibility in 24 brilliant colors. Perfect for charts, drawings—or whenever you need *moisture proof marks.*

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Leadership

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New Aids to the Constructor

Pendulum Astrolabe

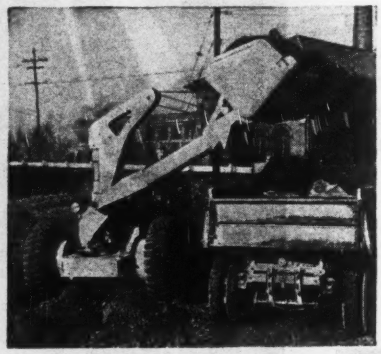
Extreme accuracy is claimed for the new pendulum astrolabe, an optical instrument having a glass reticle with 5 curved lines which represent 5 circles of constant altitude over which images of stars may be observed to transit. Stars brighter than about the 7½ magnitude may be observed. By the appropriate arrangement of a mirror on a pendulum with spring suspension and air damping, the effective altitudes of the reticle lines (which are not pendulous) are made to be constant within about a tenth of a second of arc even when the non-pendulous parts of the instrument are out of level a minute of arc. When not in use, the pendulum is held by four clamping thumb screws. If the Greenwich times or standard-zone times of the transits of three or more identified stars over one of the reticle lines are observed, the longitude and latitude of the observing station may be computed.

Total weight of astrolabe, tripod and carrying case is 40 lb.—*David White Co., 315 W. Court St., Milwaukee 12, Wis.*

• • •

Loader

Equipped with a 180-deg. swinging boom which enables it to load trucks from either side, the "Fleetfoot" loader works well in crowded spaces. Crowding, hoisting, swinging and dumping are accomplished in one rapid, continuous movement. The loader features power-controlled buckets; two-speed boom operation; six forward and six reverse travel speeds up to 15 mph. The ½ to 2 cu. yd. buckets are quickly interchangeable, and the swinging boom enables the machine to dig outside its wheels when used as an excavator.

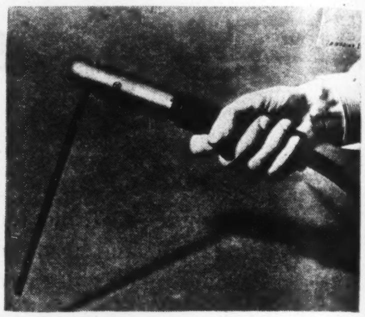


With crane booms of up to 25 ft. length, which can be installed as an attachment, the same machine is also used for pipe laying, form handling, pole setting and light steel erection. Cable controlled blade for light bulldozing can also be furnished.—*Jaeger Machine Co., Columbus, Ohio.*

• • •

Insulated Electrode Holder

Featuring a head completely enclosed in aluminum, a new screw type electrode holder is fully insulated. The aluminum armor is said to protect the insulation, resist weld spatter and eliminate accidental contact with the welding circuit, thus keeping the holder clean and prolonging its life.



The 15-oz. holder firmly grips the electrode (up to and including ¼ in. dia.) at the proper angle and maintains good current contact. The threads of the push-up rod do not carry current, and a soldered cable connection also ensures coolness. Electrode slot width limits the size of electrode used and prevents overloading.—*General Electric Co., Schenectady, N. Y.*

• • •

Triangular Tower

Light weight and simple design contribute to speedy erection of a Harco "Blizzard King" radio or structural tower. Average weight of members is 5.3 lb., while the heaviest is 8 lb. Bolt and sleeve construction is used and tower lengths are from 90 to 425 ft.

It has been found that a four-man crew can erect this tower in 10 to 50 hours, according to length.—*Harco Steel Construction Co., 1180 East Broad St., Elizabeth 4, N. J.*

• • •

Sanding Wheel

Adaptable to jobs formerly done only by hand, a new brush-backed sanding wheel, Sand-O-Flex, sands, deburrs and finishes woods, metals, plastics, rubber products, etc. A central magazine houses the strip abrasive. Eight strips extend through the housing and are held against the work by tough bristles, which cushion the abrasives, making it possible to get in and around corners, hollow and fluted surfaces and small openings.

This wheel, with an over-all diameter of approximately 8 in., weighs about 2¾ lb. fully loaded.—*Exactone Tool & Die Co. 4373 Melrose Ave., Hollywood 27, Calif.*

• • •

Car Puller

Barrel, gear box and motor are integrated into a streamlined unit in the new Lo-Hed car puller. This Class 2½ puller has a 5,000-lb. starting line pull with a single line, or more with various block combinations.—*American Engineering Co., Philadelphia 25, Pa.*

• • •

Acoustical Cement

Acoustic blocks can be secured to metal, plaster or cement ceilings without the use of mechanical fasteners, the manufacturer states, if No. 2360 Dolfinite acoustical cement is employed. This cement is said to withstand tapping and adjustment of blocks; it does not require shoring.

This product, providing a very strong bond, is heavy bodied and practically non-drying, with long fibers. It is not affected by moisture or temperature change.—*Dolphin Paint & Varnish Co., 921 Champlain St., Toledo 3, Ohio.*

• • •

Storage Tube

Available in several diameters, tubes of transparent extruded Tenite tubing are said to keep blueprints clean, untorn and easy to file. One end is sealed with a Tenite disc and the other is plugged with a wooden stopper, which bears an identifying label.

The Tenite used is a cellulose acetate butyrate product.—*Eastman Kodak Co., 10 East 40th St., New York 16, N. Y.*

• • •

Green Wire

Entirely covered with a green-colored lubricant, a new preformed wire rope is said to be exceptionally long-wearing. "Green-Lube" has high viscosity and adhesive properties. It has a grease-like consistency at normal temperatures; applied hot and molten by the pressure method, it completely covers the wires and fills the voids between them.—*American Chain & Cable Co., Bridgeport, Conn.*

• • •

Four Face Shields

Light-duty protection is provided by four new face shields—all light, sturdy and comfortable, and so designed that they may be used by workers who wear prescription glasses. Also available are three types of button-on windows for the shields: clear cellulose acetate; 24 mesh screen; and fiber with a filter glass window. Genuine leather sweat-

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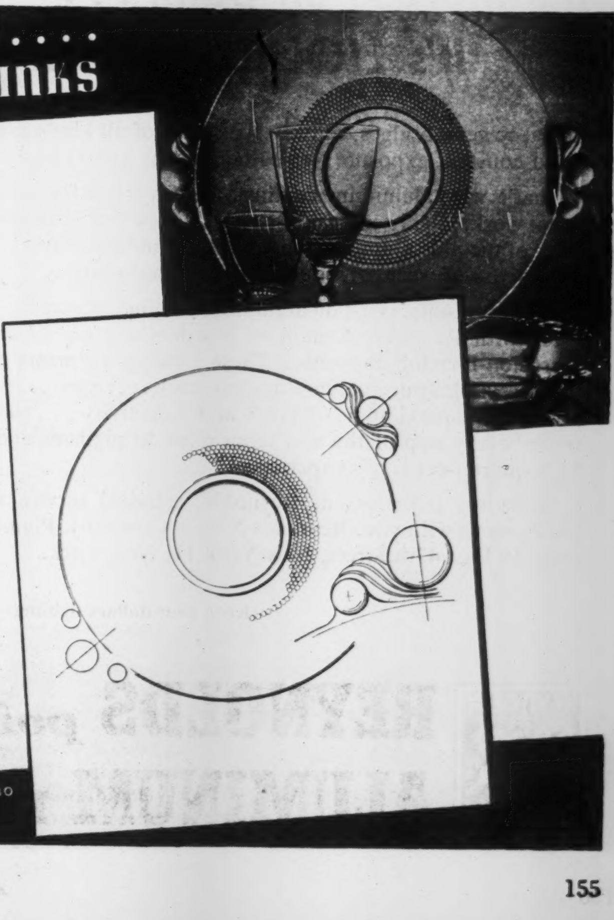

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Working drawing made with Higgins Ink by Robert A. May for Tear-drop plate, designed for the Duncan & Miller Glass Company.

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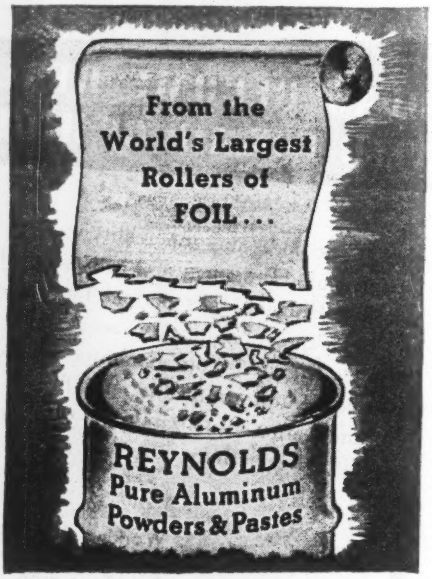

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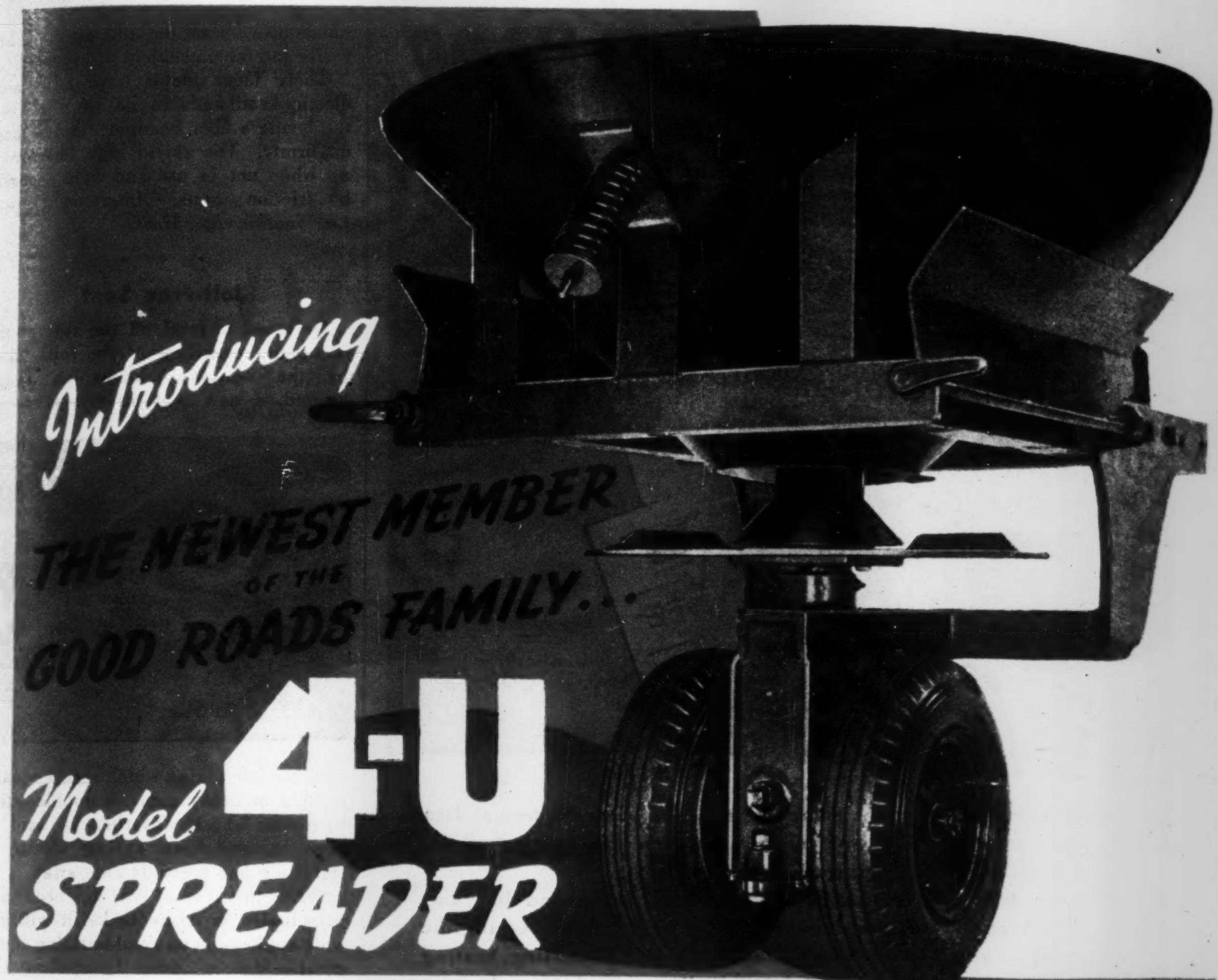

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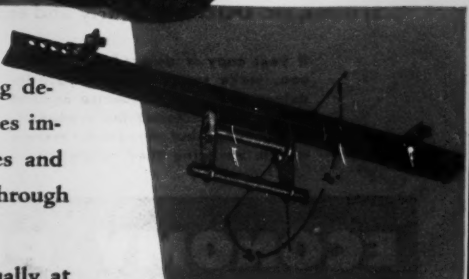
THE NEWEST MEMBER OF THE GOOD ROADS FAMILY...

Model 4-U SPREADER

Developed by demand, with actual working requirements dictating design, this worthy companion to the now famous Model 2-S possesses important improvements. Heavier, sturdier, with interfering braces and supports eliminated, the 4-U sends sand, salt, cinders or chips through a free and uninterrupted spread of 270 degrees.

Capable of handling an amazing variety of jobs, the 4-U is equally at home working on a single traffic lane or a vast airport runway. It spreads up to 25 feet at 10 miles per hour with spread width controlled by truck speed and adjustable deflector plates. Good Roads has engineered completely controlled coverage into the 4-U, and it will do a splendidly complete spreading job for you. Write for folder No. 104.



IMPROVED HITCH AND TRUCK ATTACHMENT

This new hitch swings in an arc and is adjustable to any desired position while the truck attachment remains fixed.

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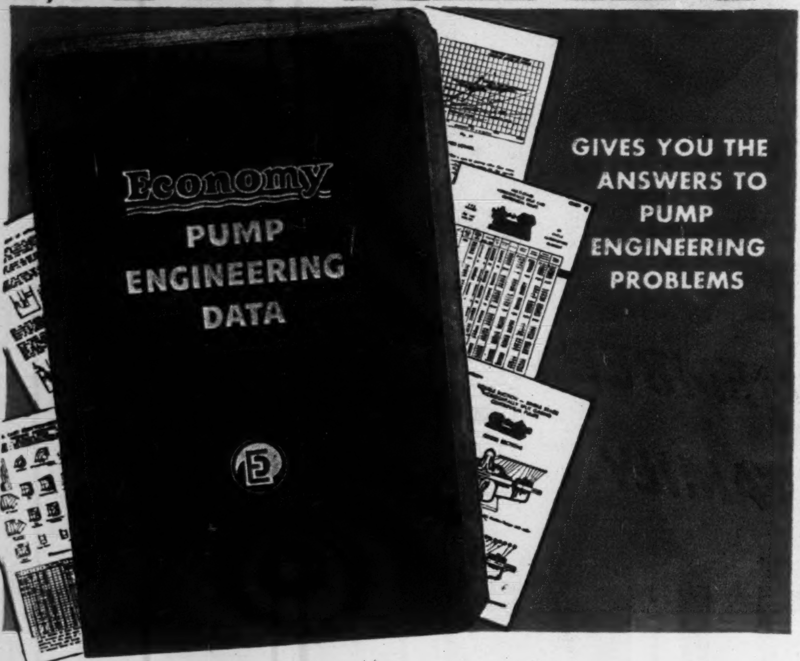

A timely contribution to the pump industry—416 pages of factual data just when vital postwar problems require authentic facts, sound experience and advanced engineering practice.

Here, under one cover, are hundreds of handy tables and diagrams you need every day. Revised, improved and new data governing the correct layout and installation of sewage, drainage, processing, heating systems, etc. Describes clearly and exactly the way to do the job right.

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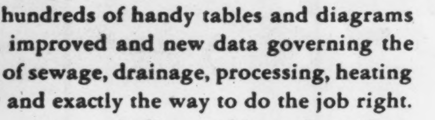
ECONOMY PUMPS, INC.
HAMILTON, OHIO • U. S. A.
FOR OVER THIRTY YEARS MAKING BETTER PUMPS DO MORE

HOW TO KEEP
IN HOT WATER
AND
OUT OF TROUBLE!



Where a steady supply of hot water is indispensable, install MARION GULF STREAM HOT WATER HEATER. Simple construction. Water heats fast through contact with adjoining steam chambers. Inexpensive investment. Utilizes low pressure steam with greatest economy.

Capacities from 370 to 3700 GPH. Instantaneous type but can be used with storage tank. WRITE US FOR DETAILS!

THE MARION LINE

MARION MACHINE, FOUNDRY & SUPPLY CO.
Marion, Indiana, U. S. A.

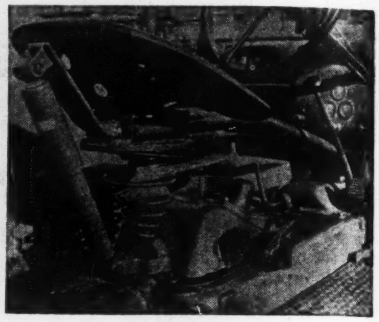
bands also button on, and all parts are easily interchangeable.

These face shields have adjustable elastic headbands to be worn low on the head; a fiber headpiece holds them on firmly. The shield may be thrown up when not in use and held securely by friction joints.—*American Optical Co., Southbridge, Mass.*

• • •

Jolt-Free Seat

Designed to level off the ride of the occupant, regardless of the jolts taken by the vehicle's chassis on rough ground, a new seat utilizes a special variable rate spring which reacts equally to light or heavy men. A double-action hydraulic shock absorber is said to resist up-and-down spring action; a stabilizer bar prevents side sway.



While this type of seat has been used principally on Army tanks, it will find wide application on road-building equipment.—*Monroe Auto Equipment Co., Monroe, Mich.*

• • •

Protective Coating

Compounded of special synthetic resins, applied like paint and drying into a tough impermeable plastic, the new Ucilon protective coating shields surfaces of tanks, pipes, process equipment, etc. It is said to resist acids, alkalies, moisture, wear and abrasion, to inhibit fungus growth, and to be chemically inert.

Ucilon, which has passed rigid testing, is available in several colors, in glossy finish or for non-reflecting surfaces.—*United Chromium, Inc., 51 East 42nd St., New York 17, N. Y.*

• • •

Single Pass Stabilizer

All necessary functions in soil preparation for road-building are combined in the new P&H single pass stabilizer, according to a recent announcement. This machine, tested under varied conditions, promises efficient, low-cost soil processing for base courses, light traffic roads, etc.—*Harnischfeger Corp., Milwaukee 14, Wis.*